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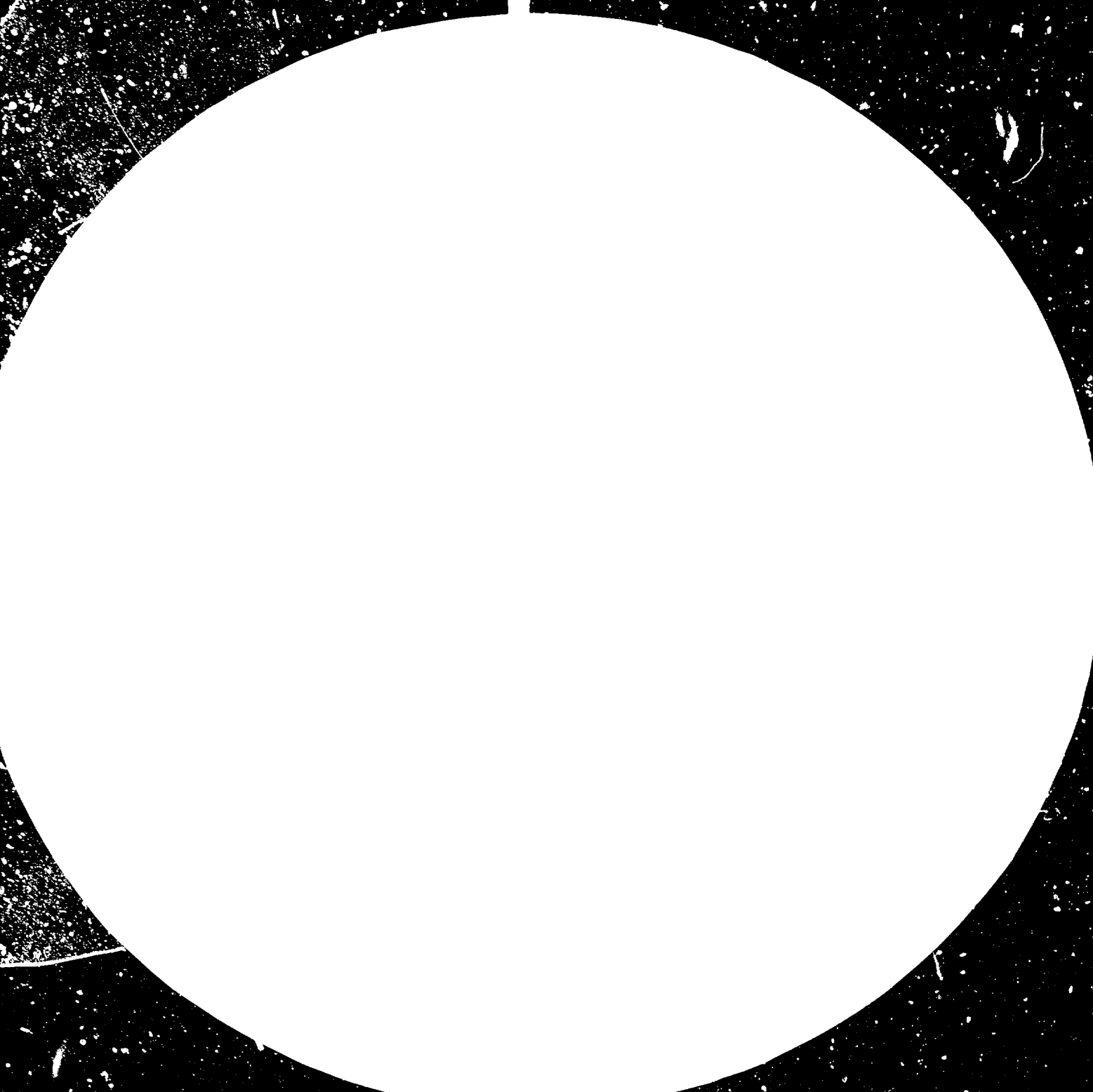


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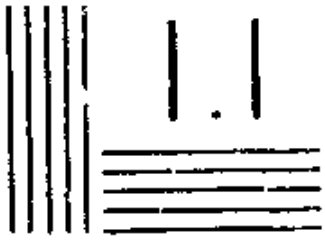
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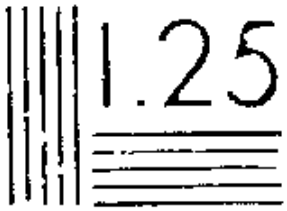
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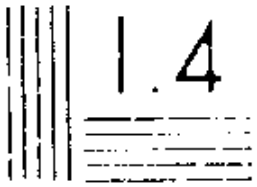
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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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4 September 1980
ENGLISH

ESTABLISHMENT OF A
COCONUT PROCESSING TECHNOLOGY CONSULTANCY SERVICE
UF/RAS/78/049

ASIAN AND PACIFIC COCONUT COMMUNITY

COCONUT PROCESSING TECHNOLOGY INFORMATION DOCUMENTS

PART 2 OF 7

"Coconut Oil Extraction"*

Based on the work of T. K. G. Ranasinghe
in co-operation with representatives of the coconut processing industry
of the Asian and Pacific Coconut Community and individual international experts

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Asian and Pacific Coconut Community

Jakarta — Indonesia

Our Nr :

P R E F A C E

A valid criticism against the poor performance of many agricultural extension services in coconut producing countries is that the services do not have or know what to "extend". A similar analogy can be applied to a consultancy service on coconut processing technology.

"Registering" coconut processes applied in the APCC countries, may be a simple achievement and considered unimportant, when one views the deluge of impressively formulated and identified objectives and programmes pouring out of international agencies and institutions. The fact is, that the disappointments from two UN Development Decades, could be traced to the failure to execute the basic "Home Work" essential for achieving the ultimate objectives.

UNIDO, which concieved and supervised the execution of this project, rightfully owns the entire credit for an important programme of meaningful benefits to APCC and APCC member countries. UNIDO has provided APCC with a firm basis from which APCC must now build and develop an essential service to those countries and individuals reliant on the coconut for their economic survival.

Godofredo P Reyes Jr
Director

13 June 1980.-

INTRODUCTION

The United Nations Industrial Development Organisation, Vienna, funded and executed this project "Establishment of Coconut Processing Technology Consultancy Service" for the Asian and Pacific Coconut Community based in Jakarta. The project was initiated in 1978 and completed within 18 months.

Coconut Processes, commercial and household, applied in the APCC member countries were documented in individual technology sheets by Consultants for specialised areas and by the Project Manager/Coconut Processing Technologist. Each technology sheet carries a product code, based on the Customs Cooperation Council Nomenclature (CCCN) which has replaced the Brussels Tariff Nomenclature (BTN). This facilitates easy reference to determine import or export duties, freight rates, etc, as well as coding for library systems. Where there are co-products or by-products in a process, only the main product has been taken into consideration for coding.

The immediate objective of the project is to make the technology sheets available to all concerned as a "Consultancy Service" in the framework of technical cooperation among developing countries and others interested in improving the coconut processing discipline.

The technology documented is not only on major commercial processes but also on the hitherto, somewhat neglected, rural and household processes. These processes offer a large scope for further development with appropriate and suitably scaled technology, in order to bring about the commercialisation of new or improved products.

The development of the Coconut Processing Sector through technical cooperation in existing commercial processes and the improvement of rural and household products, could mean higher incomes and better living conditions for several hundred million people living in the coconut areas of the world.

ACKNOWLEDGEMENT

The kind assistance and co-operation rendered by the counterparts, the national collaborating agencies and the excellent services given by the APCC Secretariat are gratefully acknowledged.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

This document is one of VII parts: -

PART I	COCONUT HARVESTING AND COPRA MANUFACTURE
PART II	COCONUT OIL EXTRACTION
PART III	COCONUT OIL REFINING AND MODIFICATION
PART IV	DESICCATED COCONUT MANUFACTURE
PART V	DOMESTIC COCONUT FOOD PROCESSES
PART VI	COCONUT COIR FIBRE AND PRODUCTS
PART VII	COCONUT SHELL PRODUCTS AND OTHER PROCESSES

These Technology sheets have been prepared by :-

P.C. Catanaoan, UNIDO Consultant on oil extraction

H.B.W. Patterson, UNIDO Consultant on oil refining

P.M. Abaca, UNIDO Consultant on non traditional food

T.K.G. Ranasinghe, UNIDO Project Manager/Coconut Processing Technologist.

1979/1980

Consultancy Service on Coconut Processing Technology

UNIDO/APCC Project UF/RAS/78/049

PART II

COCONUT OIL EXTRACTION

List of Technology sheets

Product code CCCN 15.07 1
Technology sheet no II / 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : : INTRODUCTION TO MECHANICAL AND SOLVENT EXTRACTION OF COCONUT OIL

2. Uses of finished products :

2.1 Coconut oil

Coconut oil has both food and industrial uses. It is processed into cooking oils and edible oils. Edible oil is used as "butter fat" substitute in the manufacture of "filled milk". Hydrogenated fats in the manufacture of "vegetable lard" and baker's margarine.

In industry, coconut oil is used in the manufacture of pure coconut oil soaps; with tallow, it is largely used in the manufacture of toilet and laundry soaps. In it's modified or original form, it is used as a vehicle in the paint and varnish industry. Coconut oil is also processed into methyl esters, fatty acids, and fatty alcohols. These intermediate products are the raw materials in the manufacture of detergents, plasticizers, surfactants, emulsifiers and other organic chemical products.

2.2 Copra cake or meal

Copra cake or meal is used as an ingredient in the blending of animal feeds. Due to the poor condition of the meal, it has a low price and a limited market. Because of it's aflatoxin content, some countries have stopped using it in animal feeds.

If edible - grade copra is used, and processing plants are modified for sanitary operations, edible copra meal can be produced. With about 24% protein, 53% carbohydrates and significantquantities of amino acids, edible coconut meal has a good potential as food. Edible coconut flour (pulverized edible coconut meal) has been proven to be a good admixture for wheat flour and a meat extender. With about 4 million tonnes of copra produced a year in the APCC region, about 1.2 million tonnes of edible coconut flour can be produced.

3. Country of origin

Mechanical and Solvent extraction is standard technology that has been developed in the vegetable oil industry. Equipment can be obtained from various manufacturers around the world.

4. Equipment

See section 8 for partial list of equipment manufacturers. Details of equipment for specific plant capacities are given in the respective technology sheets.

An oil extraction plant requires auxillary equipment for operation. These include a steam boiler, a power supply, and a source of water. The capacities and design of these equipments depend upon the requirements of the plant, and the local conditions.

Steam boilers may be oil fired or fueled by indigenous fuels like firewood, coconut shells, coconut husks, coconut trunks and fronds. Electricity may be provided by diesel engine driven generating units, steam turbine generators, or supplied from outside sources. Water may be pumped from deep wells and rivers or supplied from external sources. A cooling tower for recirculation of condenser water and cooling waters are usually installed to reduce water consumption.

5. Process of oil extraction

Copra, the primary product of the coconut industry; is produced by drying the kernel of mature coconuts. The quality of copra depends upon several factors, namely: the maturity of the nuts, the extent and conditions of drying; the storage and handling conditions; and to some extent, the variety of the coconut trees.

The overall objectives of extracting oil in the copra producing countries are to: -

(a) Produce oil for further processing or utilization
(b) Supply the demand for oil and meal both in the local and foreign market;
(c) Achieve an economic advantage;
(d) Extend storage life and reduce storage loss, and
(e) Achieve marketing flexibility.

The six basic steps in the process of oil extraction are: -

1. Copra storage
2. Preparation of copra
3. Oil extraction
   Full-press method
   Prepress-Solvent Method
   Full-solvent method
4. Processing of the extracted oil
5. Processing of the meal
6. Storage of products

5.1 Copra Storage

The main purpose of copra storage is to provide a buffer stock of copra to make up for differences between copra deliveries and copra processed. Incidentally, the storage performs two functions important for oil extraction: to dry the copra, and to equalise the moisture content of copra prior to processing.

Facilities for copra storage vary from plant, but the basic requirements for good storage are:

1. Protection from the elements and pests;
2. Adequate ventillation
3. Sufficient storage space; and
4. Suitable equipment for handling and movement of copra.

In large plants, a separate building (copra bodega) is used for copra storage. In small plants, the copra may be stored in an empty space within the mill building.

Piling of copra in large bodegas is arranged to facilitate first-in, first-out withdrawals so that the copra with least moisture is processed first and new copra deliveries allowed to dry in storage before processing.

5.2 Preparation of copra

The purpose of copra preparation is to cut it to the right size, dry it to the required moisture content, heat it to the right temperature, keep it at the right temperature for a sufficient period of time, and form it to the right shape, before it is subjected to extraction process. Grinding the copra opens the oils cells to expose the oil for extraction. Moisture content affects the efficiency of extraction. Increasing the temperature reduces the viscosity of the oil for easier flow, while keeping the material at a high temperature for a period of time coagulates the proteins to reduce resistance to oil flow through the material during extraction.

For solvent extraction, the material should have a maximum contact area with the solvent, the particles should be large enough to avoid erosion of the material or clogging of the extractor basket perforations. The shape of the particles should effect good percolation of the solvent through the bed of materials.

The equipment for size reduction and particle formation are: hammer mills; peg mills, disk mills; rollers and flakers. The mills break the material to the desired sizes; the rollers break and compress large particles left out after crushing, and grinding; while the flakers compress the material into thin and firm flakes suitable for solvent extraction. The size reduction equipment should not generate too much heat to cause excessive temperature rise of the material which may cause darkening of the oil.

The equipment used for drying and preheating are dryers, cookers, and conditioners. The design of these equipments are of two general types: the multi-decked kettle type, with steam-jacketed pans and revolving stirrer-scrapers; and the horizontal drum type, with steam-jacketed wall and rotating stirrer-conveyor screws. They are equipped with vapour ducts and exhaust fans.

5.3 Oil Extraction

The oil in the copra is removed by either or both of the following processes: pressing or expelling; and solvent extraction or leaching. Pressing compresses the oil bearing material and forces the liquid (oil) to escape, but retains the solid (cake).

To effect efficient oil extraction, maximum pressure should be applied on the material and sufficient time should be allowed for the oil to escape. The temperature of the material should not be allowed to rise to a level where the oil darkens due to overheating. By convention, the chunky residue extruded out of the expellers or press is called "copra cake" while the ground copra cake is called "Copra meal". Others use the term copra cake for expeller residues regardless of size, while the residue from solvent extraction is called meal.

In solvent extraction, the oil in the material is leached with a suitable solvent under suitable conditions. In the process, oil (the soluble material) is dissolved by the solvent while the meal (the insoluble material) is retained unaffected by the solvent.

The extent of extraction is affected by the following factors: the kind of solvent; the temperature of the solvent; the ratio of solvent to the meal; the number of extraction stages; the shape of the particles; the porosity of the material; and the contact time.

The most common solvent used is hexane, because of its price, low toxicity; suitable boiling point for recovery and handling; and its availability. Solubility of oil in hexane increase with temperature.

The resultant streams from solvent extraction are: the miscella or oil-solvent solution; and the extracted meal which is composed of the meal, some solvent, and a little oil. The solvent in the meal is removed by heating to boil off the volatile solvent and recovering the solvent by condensation. The solvent from the miscella is removed and recovered by evaporation and condensation. Traces of solvent left in the meal and the oil are removed by steam stripping under reduced pressure.

There are three general methods of oil extraction: the full-press or mechanical method; the prepress-solvent method or mechanical-chemical method; and the full-solvent or chemical method. In the full-press method the prepared material is pressed between the screws (worm) and the cage (slitted steel bars). Pressing may be single or double stage. The extraction pressure is controlled by a choke unit. By adjusting the clearance in the choking device the thickness of the cake can be adjusted. To prevent overheating of the oil, the shaft is usually hollow for water cooling, and oil is sprinkled over the cage bars.

In the prepress-solvent process, the copra is partially deoiled by preliminary low-pressure mechanical extraction, then subjected to solvent extraction to remove most of the oil left. The oil content of the prepressed cake ranges from 16 to 20% for optimum operations.

The equipment used for the prepressing may be similar to expellers for full-pressing (with adjustments for higher throughput) or a special prepressing expeller with single pressing screw. The equipment for solvent extraction consist of two general types: the roto-cell type with cells revolving around a vertical axis; and the basket type, with baskets travelling horizontally; while the dissolving liquid is sprayed over the material in countercurrent flow.

In the full-solvent process, the prepared copra is first subjected to a first extraction (percolation), using the weak miscella from the second extractor as starting solvent, and producing the strong miscella for oil recovery. The extracted meal is then flaked and then subjected to a second extraction (immersion) which uses fresh solvent as starting solvent and produces the weak miscella solvent for the first extractor.

The solvent with the extracted oil is removed in a Desolventizer-Toaster (DT). The DTs are either of the multidecked vertical design with steam-heated pans and paddle-scrappers, or the horizontal barrel type with rotating conveying paddles attached to a horizontal shaft, and steam -jacketed walls. They are equipped with condensers for solvent recovery and scrubbers to remove entrained dusts leaving with the vapors. In some designs, the heat with the vapors leaving the DT are used to pre-concentrate the miscella prior to evaporation of the miscella.

The solvent with the miscella is recovered, first by an evaporator, usually of the falling-film type, where the hexane is distilled off by indirect steam heating and then by a stripping column where the traces of hexane in the oil are stripped oy steam under vacuum. The water-hexane vapors from the stripper are condensed and collected in a water-hexane separator where hexane is separated by gravity from the water. The hexane separated is decanted and reused in the extraction.

Vent vapors of hexane from the extractors and condensers are recovered in a vent recovery system where the hexane is absorbed by mineral oil. The hexane is recovered from the mineral oil by stripping and recycled to the extractor.

In some plants the miscella leaving the extractor is filtered before it is fed to the evaporator. In certain types of extractors, the miscella is clear enough for evaporation, without filteration.

5.4 Processing of the Extracted Oil

The oil from the expellers contain substantial quantities of solids (foots) that should be removed before the oil is pumped to the storage tanks. The oil is cleaned in two stages: First by settling and screening, and then by filteration. The screening equipment is a rectangular steel tank equipped with a continuous drag chain conveyor with scraper blades which scoop the settled solids and lift them over a fine screen for drainage at one end of the screening tank and are conveyed back to the expellers to be mixed with the copra.

The filtering equipment is generally a plate and frame filter press with canvass filtering media. Some plants use leaf filters with perforated steel filtering leaves. The foots or filter cake from the filters are recycled to the expellers for oil extraction.

The oil product from solvent extraction is free of solids. It leaves the stripping column at about 120°C. The oil is cooled then pumped to the storage tanks through the oil meter.

5.5 Processing the Copra Meal

The copra cake leaving the expellers are at about 110°C. They are cooled through a cake cooler. The cakes cascade down the cooler baffles and are cooled by a cross-flow of cool air from blowers. After cooling they are ground to fine particles by hammer mills or disk mills. The ground cakes may be bagged

for the local market or the pelletized for export. If they are to be pelletized, they are first moistened with water to about 12% moisture and then fed to the pellet mill. Moistening the meal improves the pelleting property of the meal. Increasing the moisture content of pellets to about 12% is required if the product is to be exported.

5.6 Storage of Products

The oil is stored in vertical cylindrical storage tanks usually made of steel. Since they are usually installed outside the buildings, they are equipped with covers, usually conical. Top and bottom manholes are provided for cleaning.

The capacity of the tanks depend upon several factors, such as:

1. The capacity of the plant
2. The frequency and volume of withdrawals
3. Marketing factors.

If the oil is to be shipped out to the market, the minimum oil storage capacity should be the volume of the biggest shipment. Normally storage should provide for 15 days production of oil.

The unpelletized cake should be bagged in woven sacks and stacked on pellets, about 10 high, in the meal bodega. This provides for adequate ventillation and easier handling. Pelletized meal for export may be bagged before storage or stored in bulk depending on the shipment system.

It is hazardous to store unpelletized meal in bulk for long periods. If they have to be stored unbagged, the piles should be kept small and should be turned over as frequently as necessary to prevent spontaneous burning. Pellets require special equipment requiring added investment which small plants may not afford. However, meal for exports have to be pelletized for safer and easier handling and conveying.

As a rule the oil content of copra meal should not exceed 10% and the moisture content should not exceed 12%. The sum of the oil content and the moisture content should not exceed 18%.

6. Flow diagrams

The following flow diagrams are attached

6.1 Simplified general flow diagram - copra oil extraction

6.2 Flow sheet for mechanical extraction

6.3 Flow sheet for solvent extraction

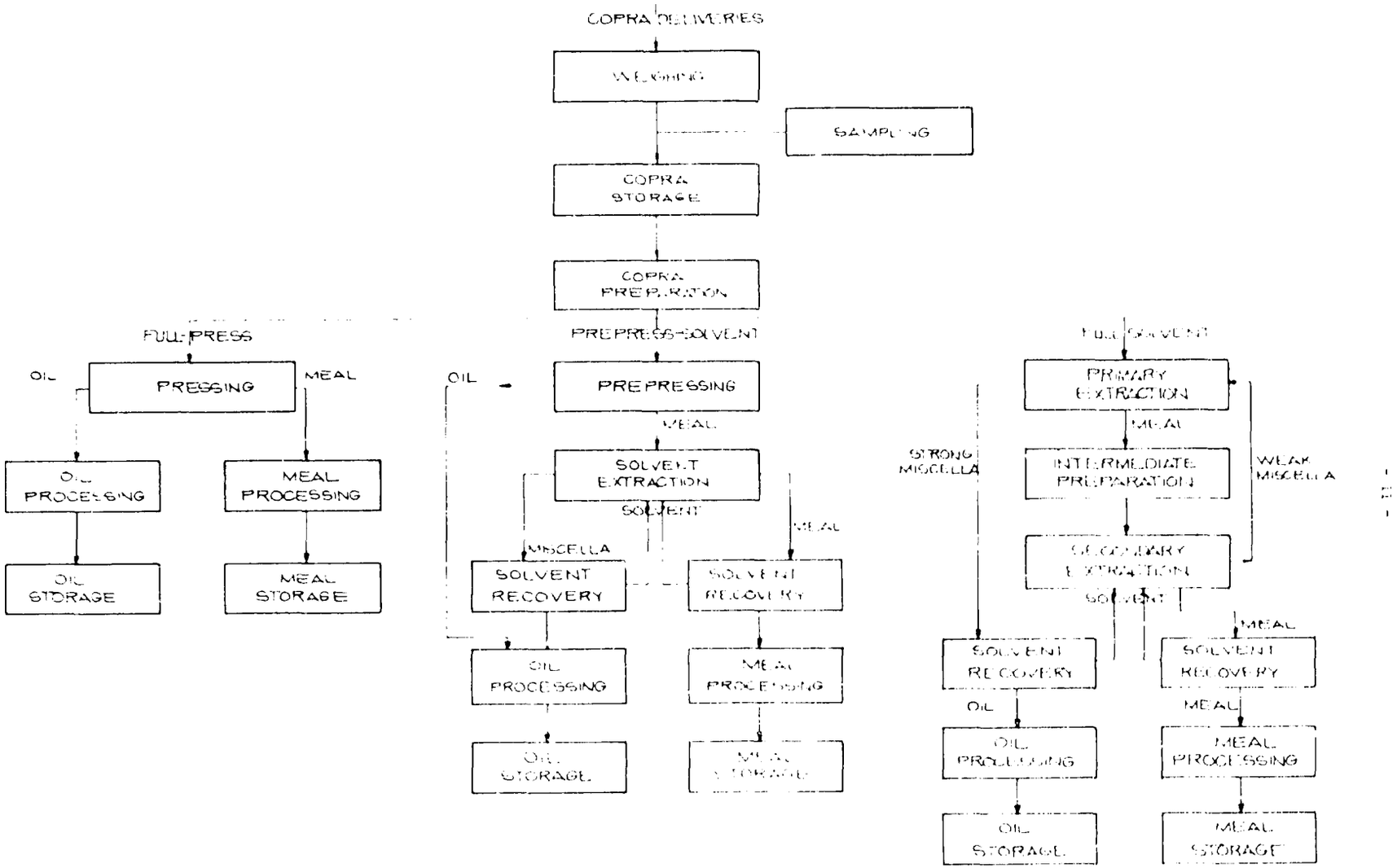
6.4 Flow sheet for a full-press extraction plant by Anderson I.B.E.C.

6.5 Flow sheet for a prepress extraction plant by Fried Krupp

6.6 Flow sheet for a prepress solvent extraction plant by Fried Krupp

6.7 Flow sheet for copra preparation for full-solvent extraction plant by C.M.B.

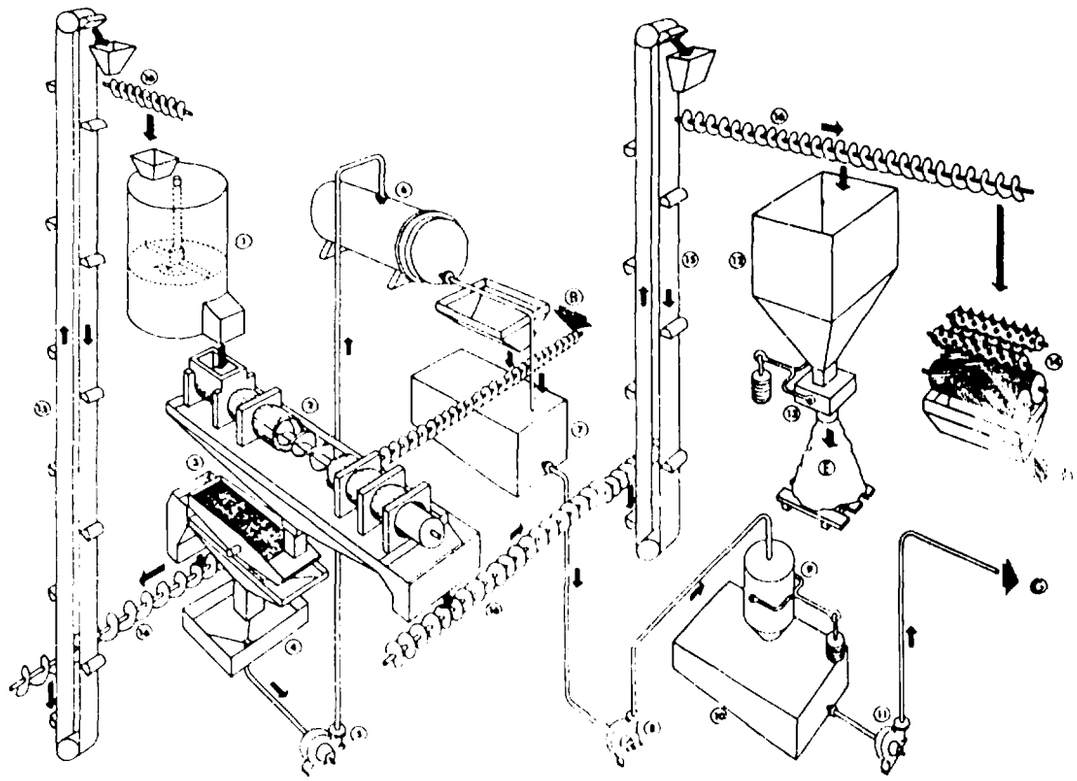
6.8 Flow sheet for full-solvent extraction plant by C.M.B.



6·1 SIMPLIFIED GENERAL FLOW DIAGRAM
COPRA OIL EXTRACTION

6·2

Mechanische Ölgewinnung
Mechanical oil extraction
Extraction mécanique d'huile
Extracción mecánica de aceite



Rohölgewinnung
Crude oil production
Extraction d'huile brute
Extracción de aceite crudo

6·2

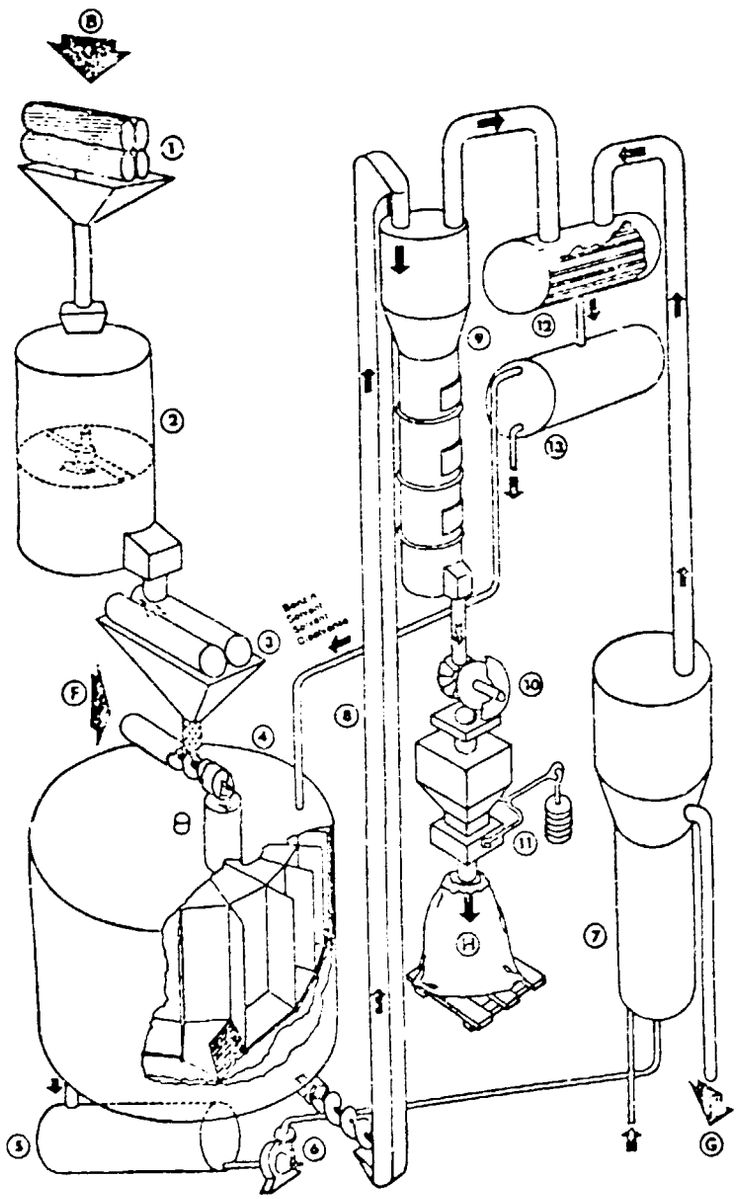
1 Wärmpfanne
2 Schneckenpresse
3 Ölrutschvibrator
4 Trübölbehälter
5 Filterpreßpumpe
6 Rohölfilter
7 Ölzwischenbehälter
8 Ölpumpe
9 Ölwaage
10 Ölbehälter
11 Ölpumpe
12 Schiller-Silo
13 Absackwaage
14 Schilferbecher
15 Becherwerke
16 Förderschnecken
B Saat zur Ölgewinnung
E Abgesackte Schilfer
F Vorgepreßte Schilfer
Q Rohöl

1 Heating kettle
2 Screw press
3 Oil foota vibrating scre
4 Tank for oil with foots
5 Filter press pump
6 Crude oil filter
7 Intermediate oil tank
8 Oil pump
9 Oil balance
10 Oil tank
11 Oil pump
12 Cake bin
13 Bagging balance
14 Cake breaker
15 Bucket elevator
16 Worm conveyor
B Seed for oil production
E Bagged cake
F Pre-pressed cake
Q Crude oil

1 *Chauffoir*
2 Presse à vis
3 Tamis vibrant pour la séparation des pieds
4 Réservoir à huile troubl
5 *Pompe à filtre-presse*
6 Filtre à huile brute
7 Réservoir intermédiaire
8 Pompe à huile
9 Balance à huile
10 Réservoir à huile
11 Pompe à huile
12 Silo à écailles
13 Ensacheur-peseur
14 Broyeur à écailles
15 Elévateurs à godets
16 Vis transporteuses
B Graines pour l'extraction d'huile
E Ecailles ensachées
F Ecailles prépressées
Q Huile brute

1 *Caldera*
2 Prensa Continua
3 Criba de vibración para eliminar los posos
4 Tanque para aceite turb
5 Bomba de filtro-prensa
6 Filtro para aceite crudo
7 Tanque intermedio para aceite
8 Bomba para aceite
9 Balanza para aceite
10 Tanque para aceite
11 Bomba para aceite
12 Silo para tortas
13 Balanza ensacadora
14 Trituradora de tortas
15 Elevadores de cangilon
16 Transportadores sin fin
B Semilla para la extracci do aceite
E Tortas ensacadas
F Tortas praprensadas
Q Aceite crudo

Lösungsmittelextraktion
Solvent Extraction
Extraction par solvant
Extracción de solvente



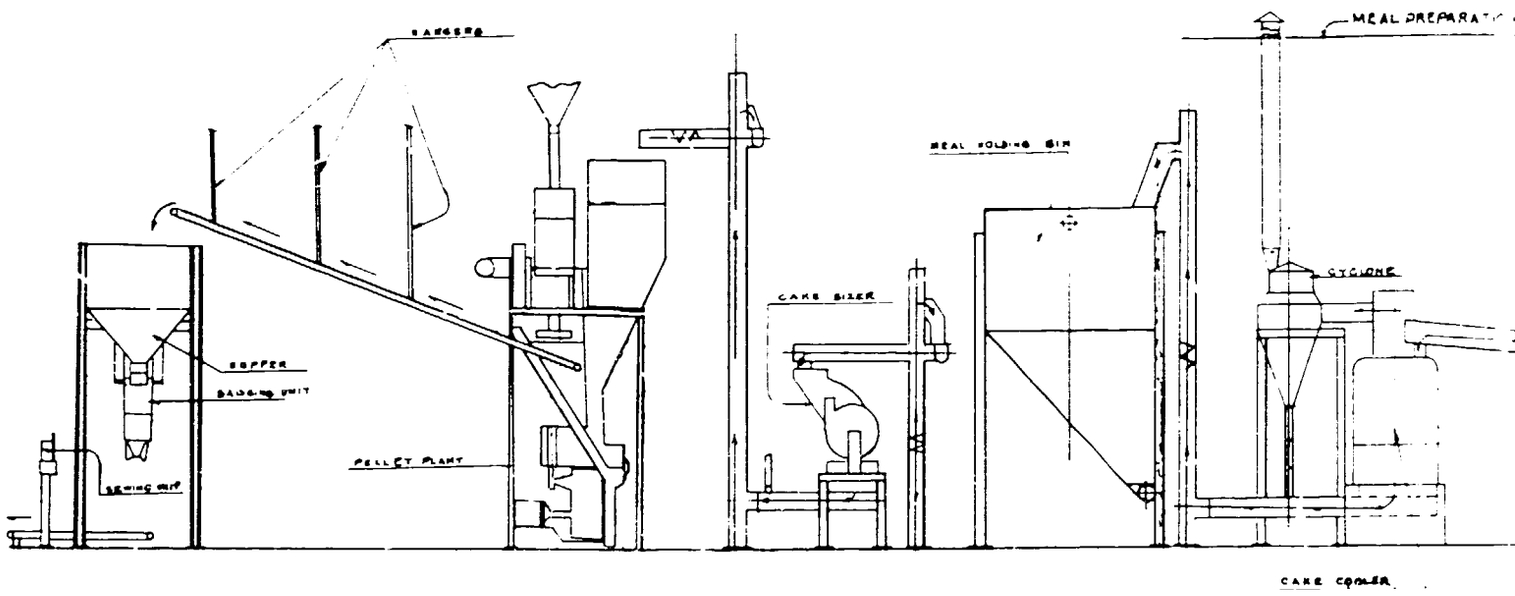
Extraktionsanlage
Extraction plant
Installation d'extraction
Planta de extracción

1 Riffelwalzwerk
2 Wärmepfanne
3 Quetschwalzwerk
4 Rotocel-Extrakteur
5 Miscella-Behälter
6 Miscella-Pumpe
7 Verdampfer
8 Schrot-Elevator
9 Desolventizer-Toaster
10 Klumpenmühle
11 Absackwaage
12 Kondensator
13 Benzin-Wasserscheider
B Saat zur Ölgewinnung (Sojabohnen)
F Vorgepreßte Schilfer
G Rohöl
H Schrot

1 Set of fluted breaker rolls
2 Heating kettle
3 Flaking mill
4 Rotocel extractor
5 Miscella tank
6 Miscella pump
7 Evaporator
8 Meal elevator
9 Desolventizer toaster
10 Lump mill
11 Bagging balance
12 Condenser
13 Solvent/water separator
B Seed for oil production (soybeans)
F Pre-pressed cake
G Crude oil
H Meal

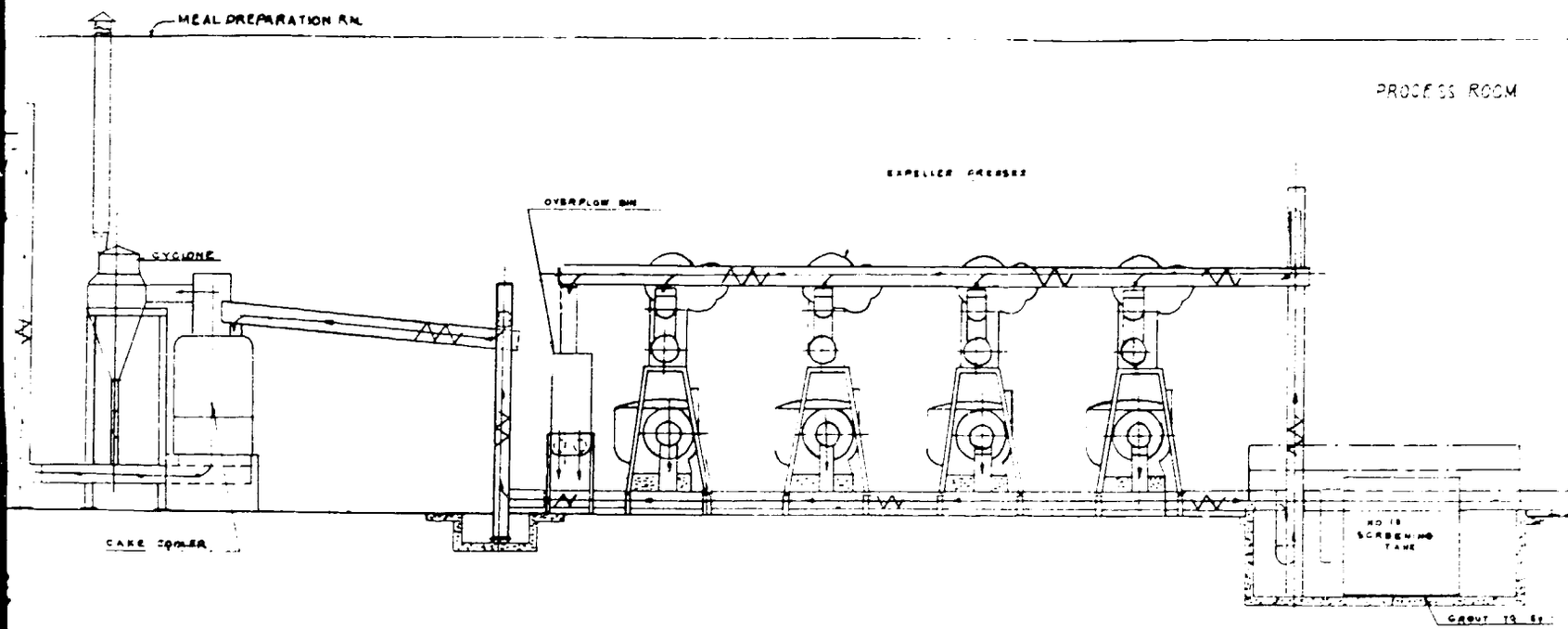
1 Broyeur à cylindres cannelés
2 Chaudoir
3 Broyeur aplatisseur
4 Extracteur Rotocel
5 Réservoir à miscella
6 Pompe à miscella
7 Evaporateur
8 Elévateur à farine
9 Tour DT
10 Broyeur pour boules
11 Ensacheur-peseur
12 Condenseur
13 Séparateur solvant/eau
B Graines pour l'extraction d'huile (graines de soya)
F Ecailles prépressées
G Huile brute
H Farine

1 Trituradora de rodillos estriados
2 Caldera
3 Molino aplastador
4 Extractor Rotocel
5 Tanque para miscela
6 Bomba para miscela
7 Evaporador
8 Elevador para harina
9 Desolventizador-tostador
10 Rompedora de bolas
11 Balanza ensacadora
12 Condensador
13 Separador de disolvente y agua
B Semilla para la extracción de aceite (habas de soya)
F Tortas prepresadas
G Aceite crudo
H Harina

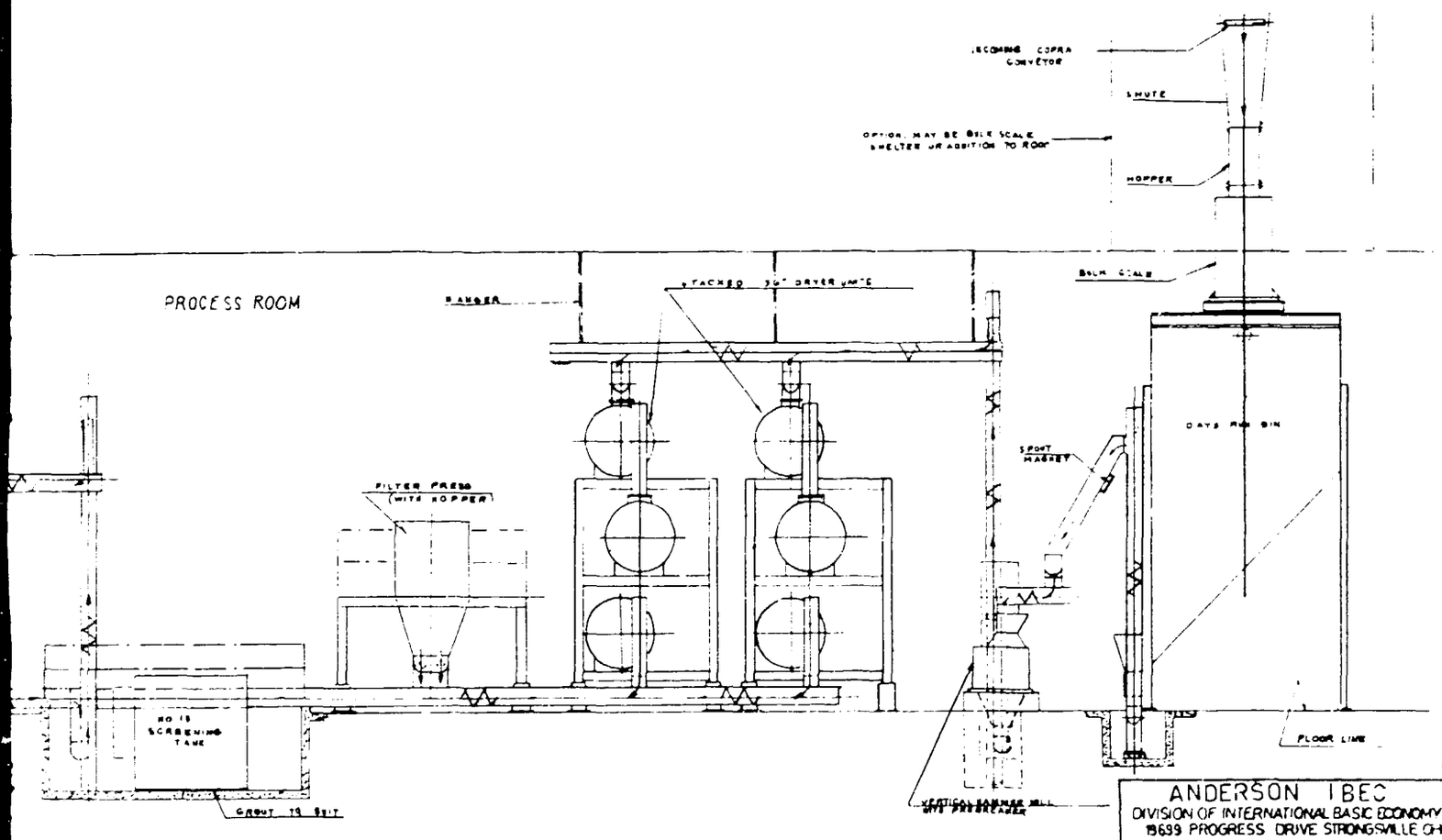

HANGERS
MEAL PREPARATI
VA
MEAL HOLDING BIN
CAKE SIZER
CYCLONE
HOPPER
PELLET PLANT
CAKE COOLER

SECTION 1

FLOWSHEET FULL-PRESS EXTRACTION PROCESS



SECTION 2

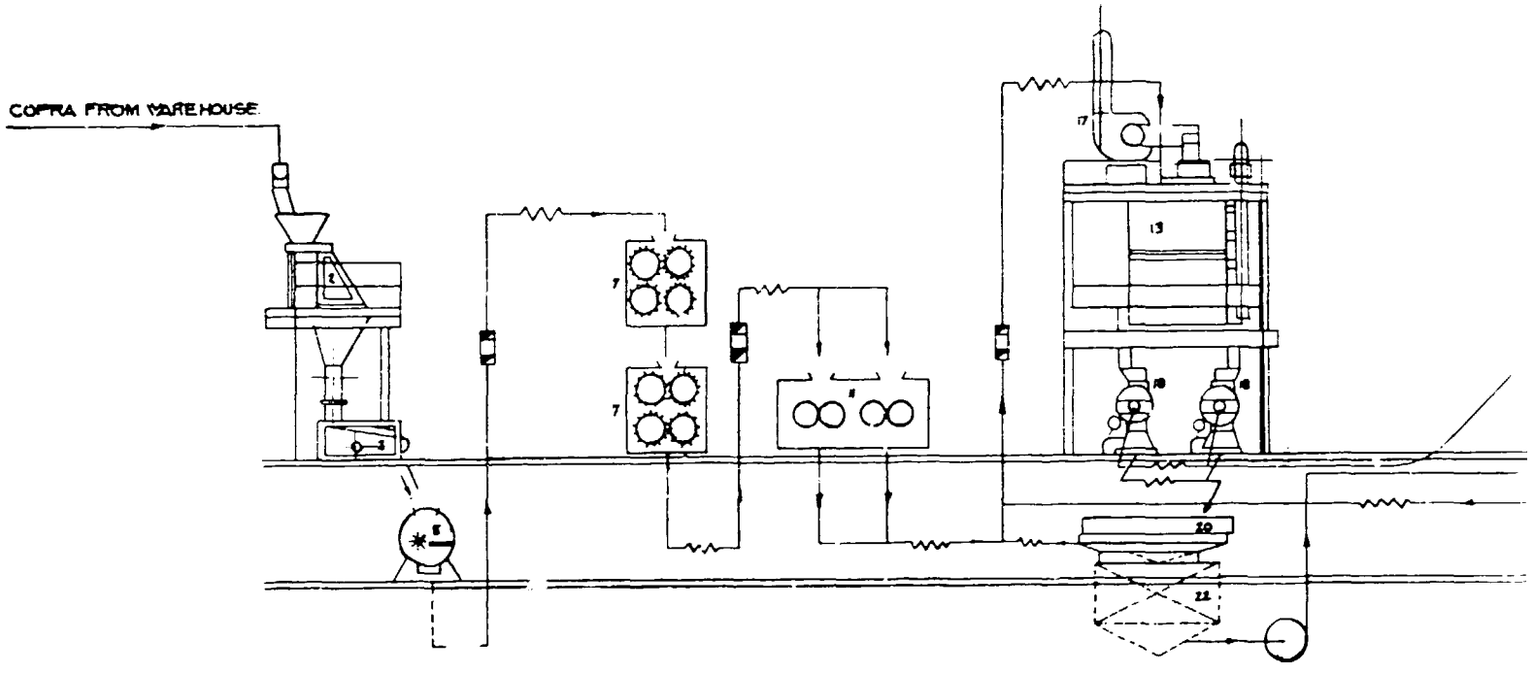


6-4

ANDERSON IBEC
DIVISION OF INTERNATIONAL BASIC ECONOMY CORP.
19699 PROGRESS DRIVE STRONGSVILLE OHIO 44136

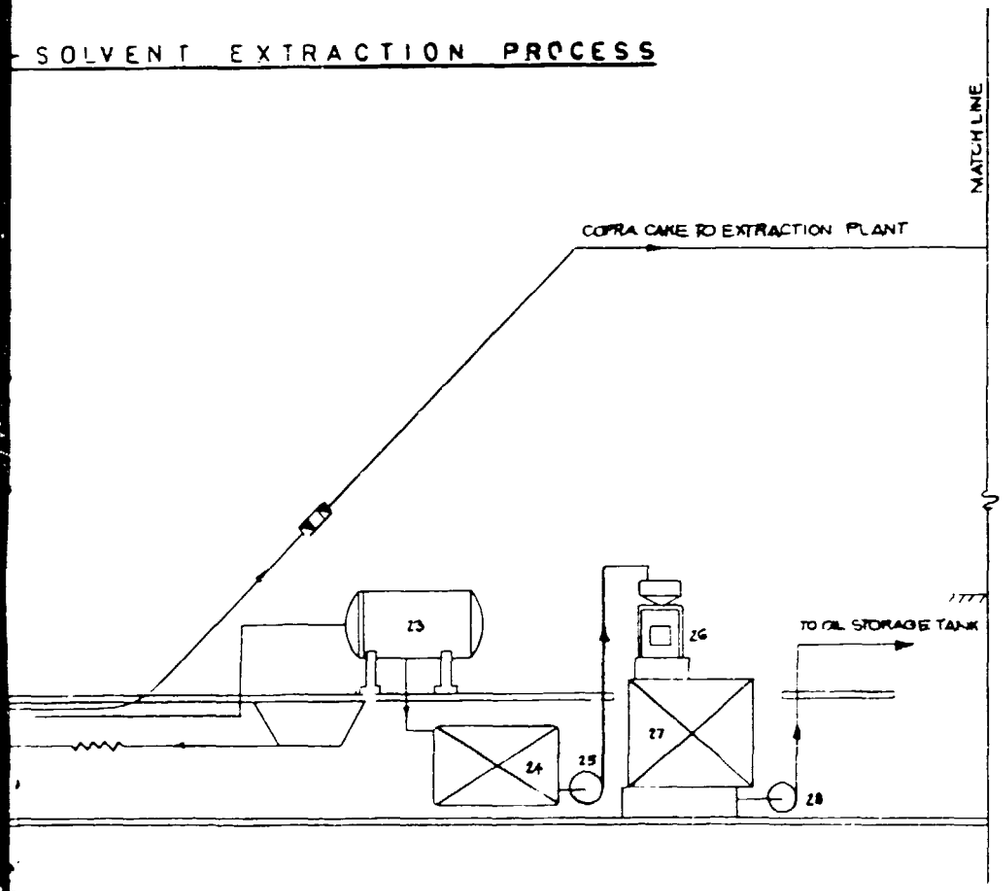
SECTION 3

FOR PREPRESS - SOLVENT



SECTION 1

SOLVENT EXTRACTION PROCESS



PRE-PRESSING PLANT

NO	DESCRIPTIONS
1	COPRA BALANCE
3	TRAMP IRON SEPARATOR
5	COPRA CUTTER
7	DOUBLE FLUTED BREAKER ROLL
11	FLAKING ROLL
13	CONDITIONER
17	EXHAUST BLOWER
18	AUTOMATIC EXPELLER
20	VIBRATION SCREEN
22	OIL TANK
23	OIL FILTER
24	OIL TANK
25	OIL PUMP
26	OIL BALANCE
27	OIL TANK
28	OIL PUMP

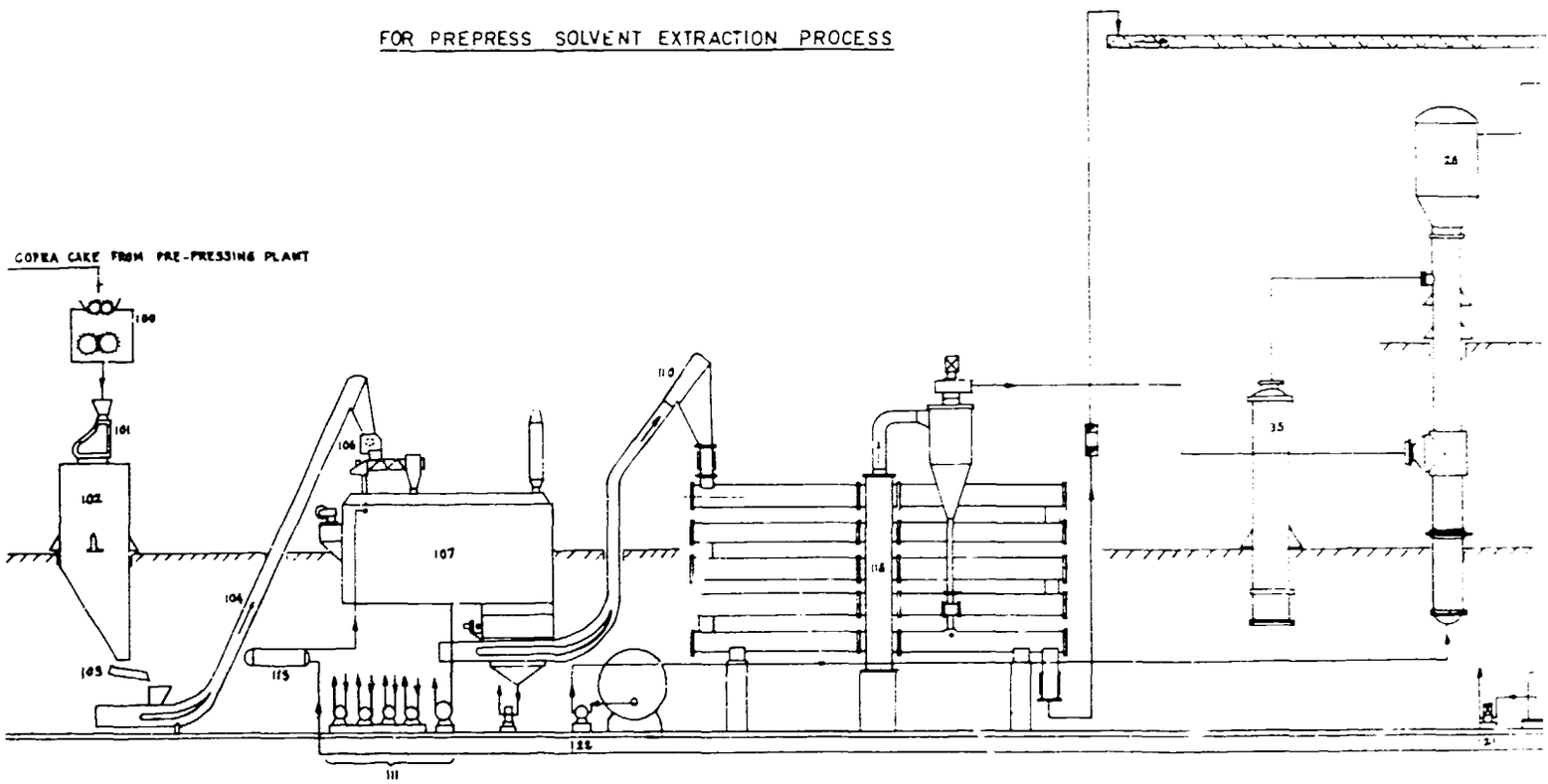
F R I E D K R U P P G M B H

KRUPP
MASCHINENFABRIKEN HARBURGER MASCHINENBAU

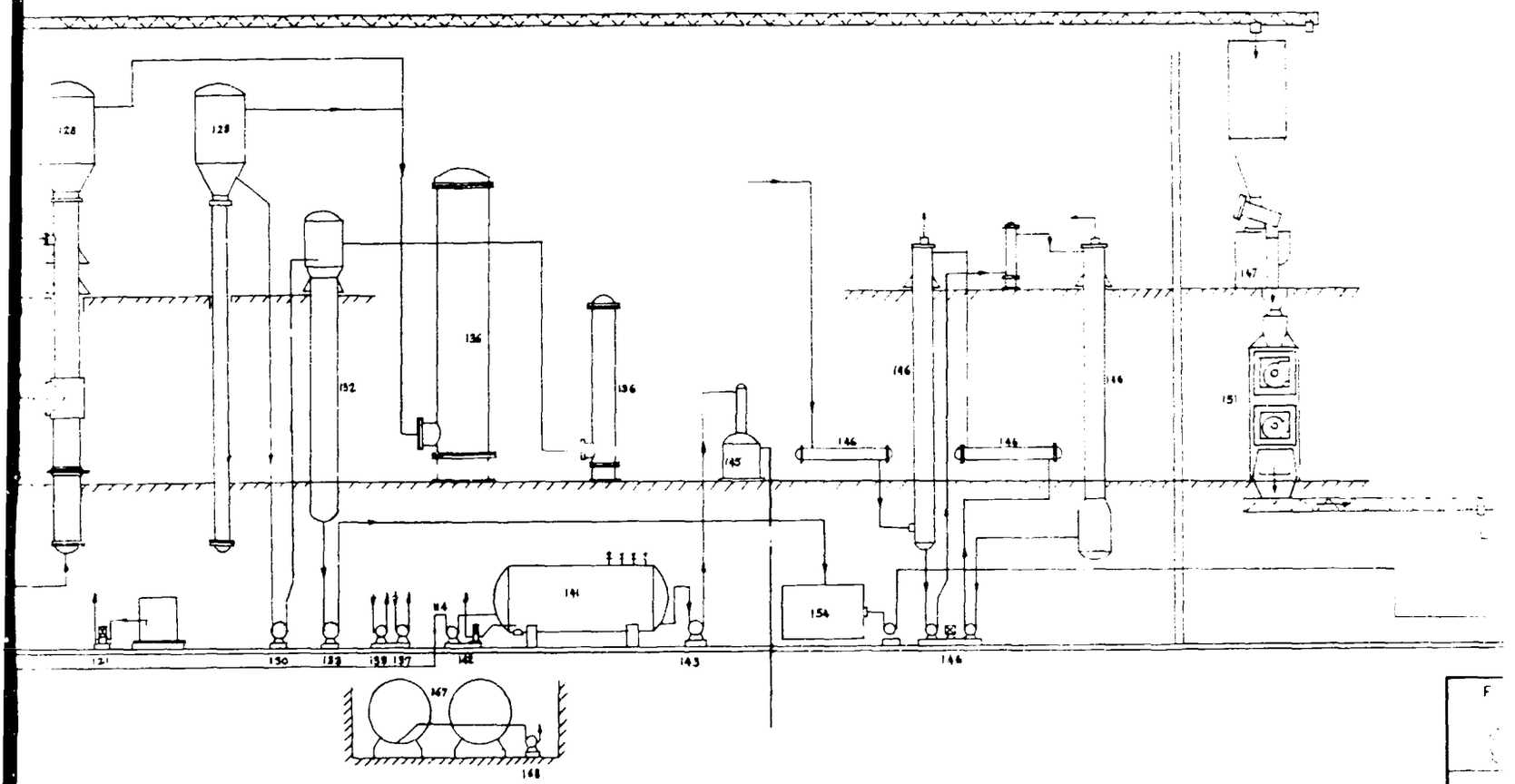
DWG. NO.	FLOWSHEET COPRA OIL MILL PRE-PRESSING PLANT 6.5	DATE

SECTION 2

FOR PREPRESS SOLVENT EXTRACTION PROCESS



SECTION 1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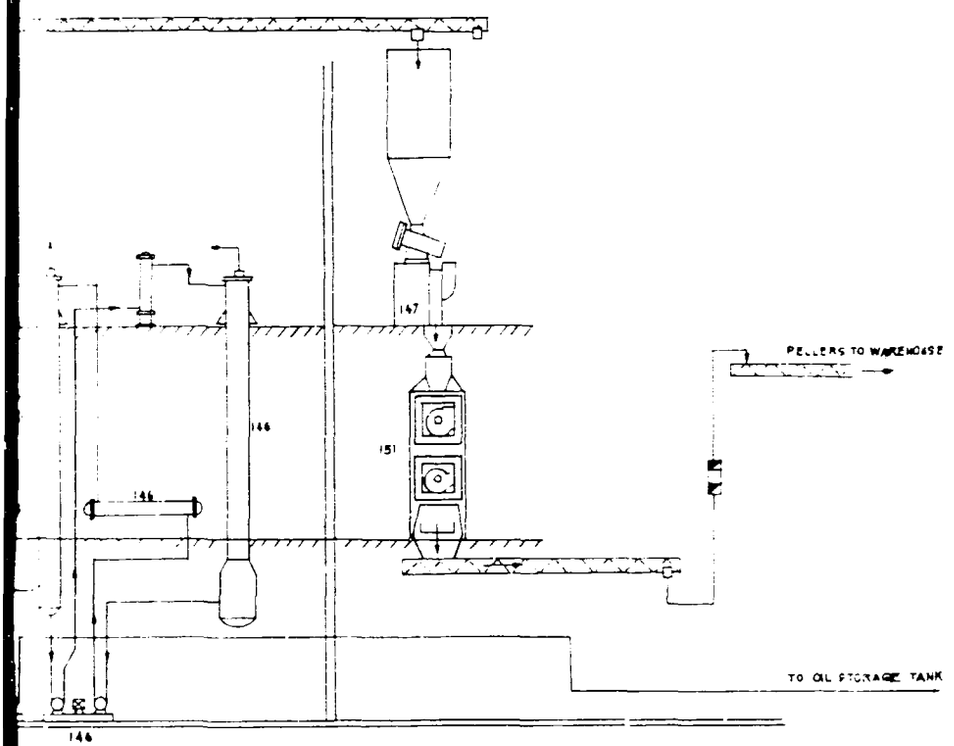
SECTION 2



EXTRACTION PLANT

NO	DESCRIPTIONS
100	CAKE BREAKER
101	BALANCE
102	STORAGE BIN
103	VIBRATION CHUTE
104	CONVEYOR
106	MAGNETIC DRUM
107	ROTOCEL EXTRACTOR
111	MISCELLA PUMPS
113	SOLVENT PRE-HEATER
114	SOLVENT PUMP
116	CONVEYOR
118	DESOLVENTIZER
121	CONDENSATE PUMP
122	FILTER PUMP
124	MAIN EVAPORATOR
125	POST EVAPORATOR
130	MISCELLA PUMP
132	STRIPPING COLUMN
135	PUMP
135	CONDENSER
136	CONDENSER
137	VACUUM PUMP
139	CONDENSATE PUMP
141	SOLVENT/WATER SEPARATOR
142	SOLVENT/WATER PUMP
143	WASTE WATER PUMP
145	WATER STRIPPER
146	ABSORPTION PLANT
147	PELLETIZING PRESS
151	PELLET COOLER
154	INTERMEDIATE TANK

FRIED KRUPP GMBH

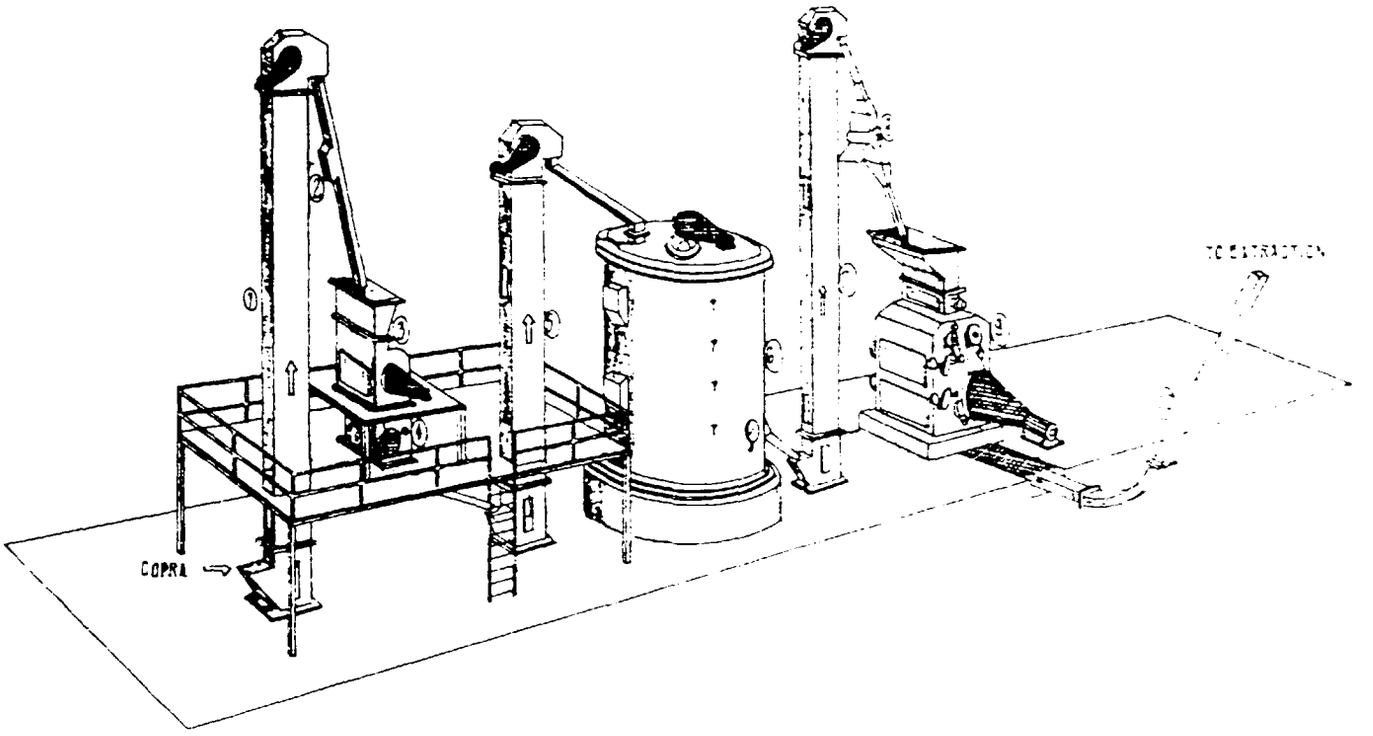
KRUPP MASCHINENFABRIKEN HARBURGER MASCHINENBAU

FLOWSHEET COPRA OIL MILL

SOLVENT EXTRACTIONPLANT 6.6

SECTION 3

FOR FULL-SOLVENT EXTRACTION PROCESS

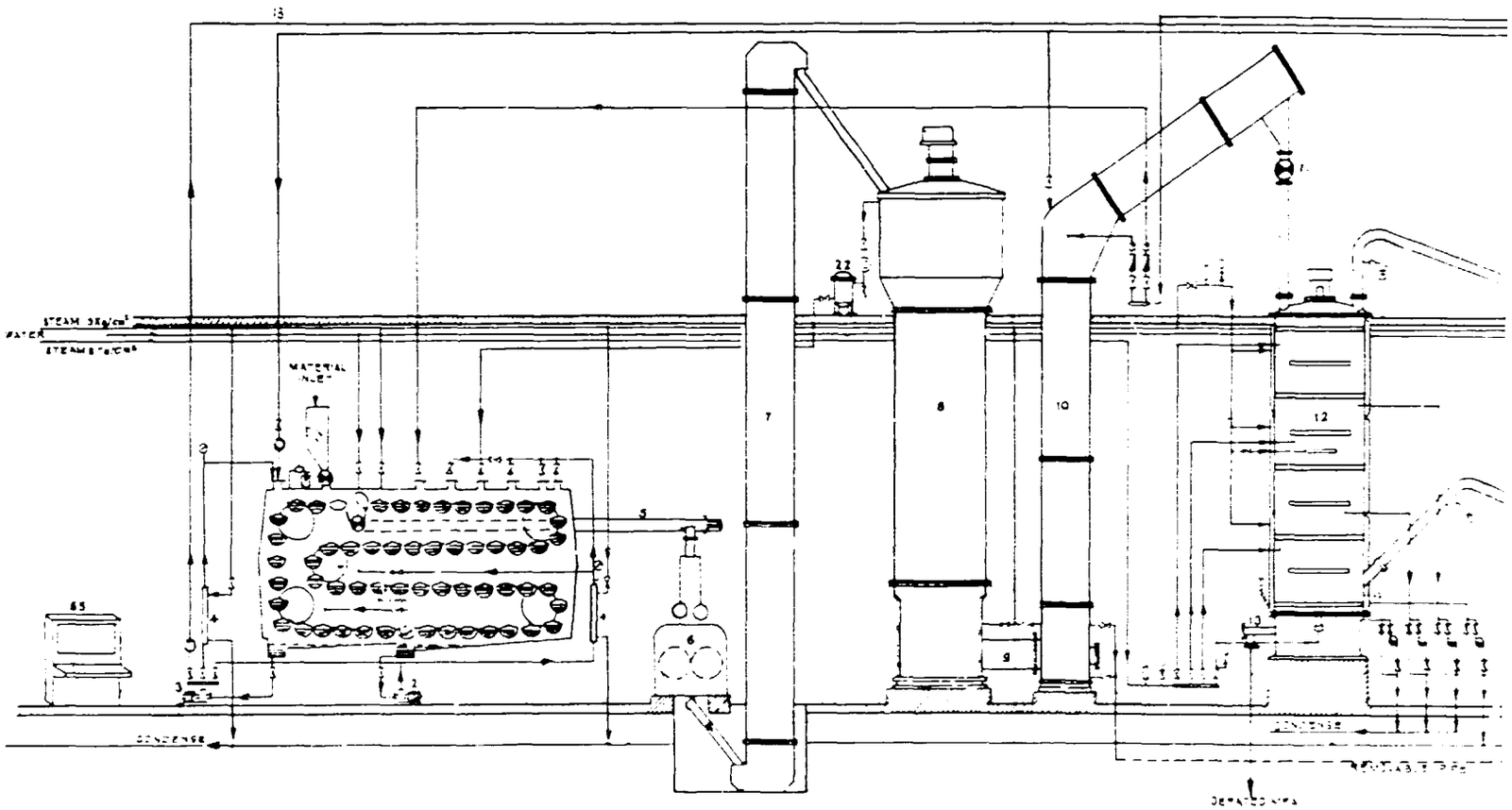


SIMPLIFIED STANDARD FLOWSHEET
COPRA PREPARATION

Legend:

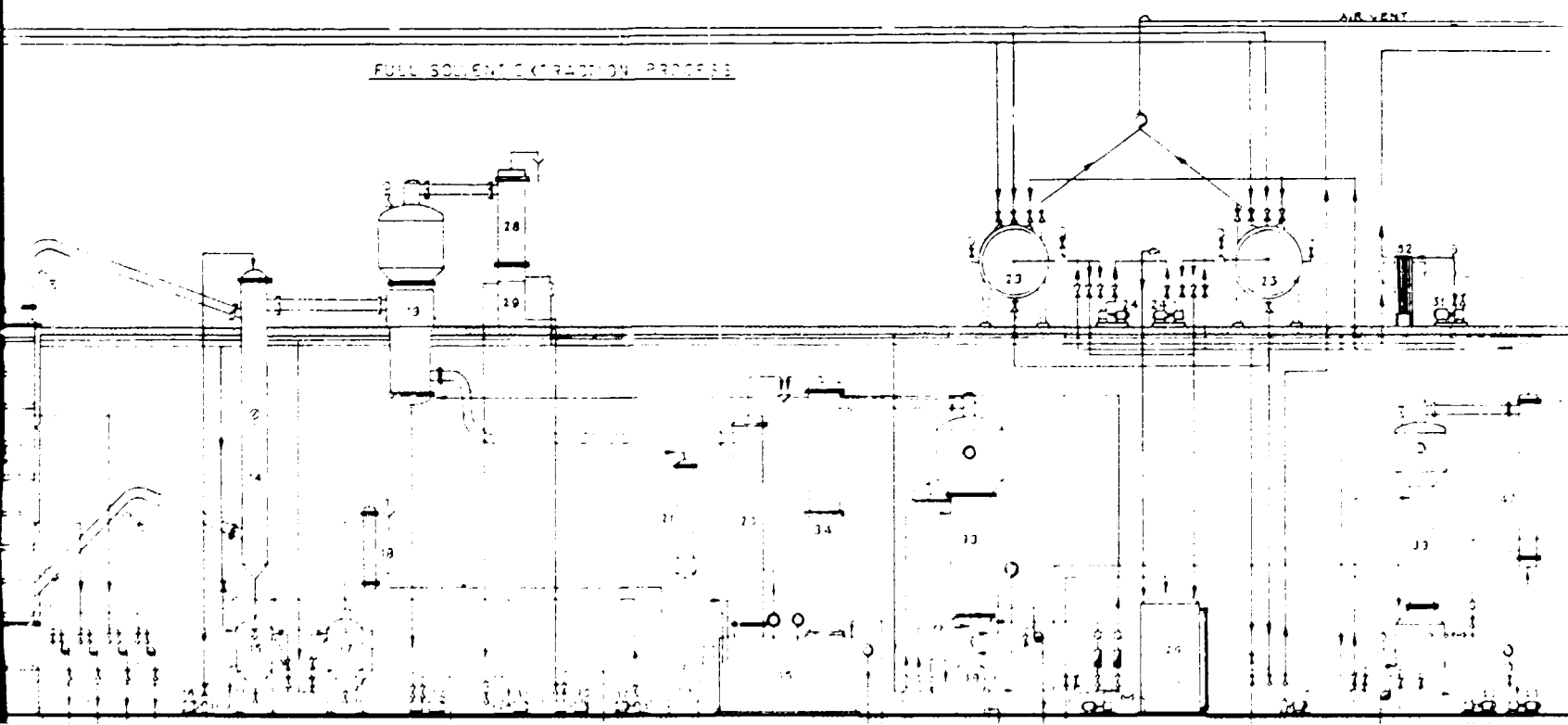
1. BUCKET ELEVATOR
2. PLATE TYPE MAGNETIC SEPARATOR
3. FIRST-PASS COPRA BREAKER
4. SECOND-PASS COPRA BREAKER
5. BUCKET ELEVATOR
6. COOKER CONDITIONER
7. BUCKET ELEVATOR
8. ROTARY TYPE MAGNETIC SEPARATOR
9. TWO-HIGH ROLLER MILL
10. CHAIN CONVEYOR

COSTRUZIONI MECCANICHE BERNARDINI
VIA DELLA PETRONELLA 00040 POMEZIA (ROME) ITALY



SECTION 1

SIMPLIFIED STANDARD FLOWSHEET
"DIREX 40"



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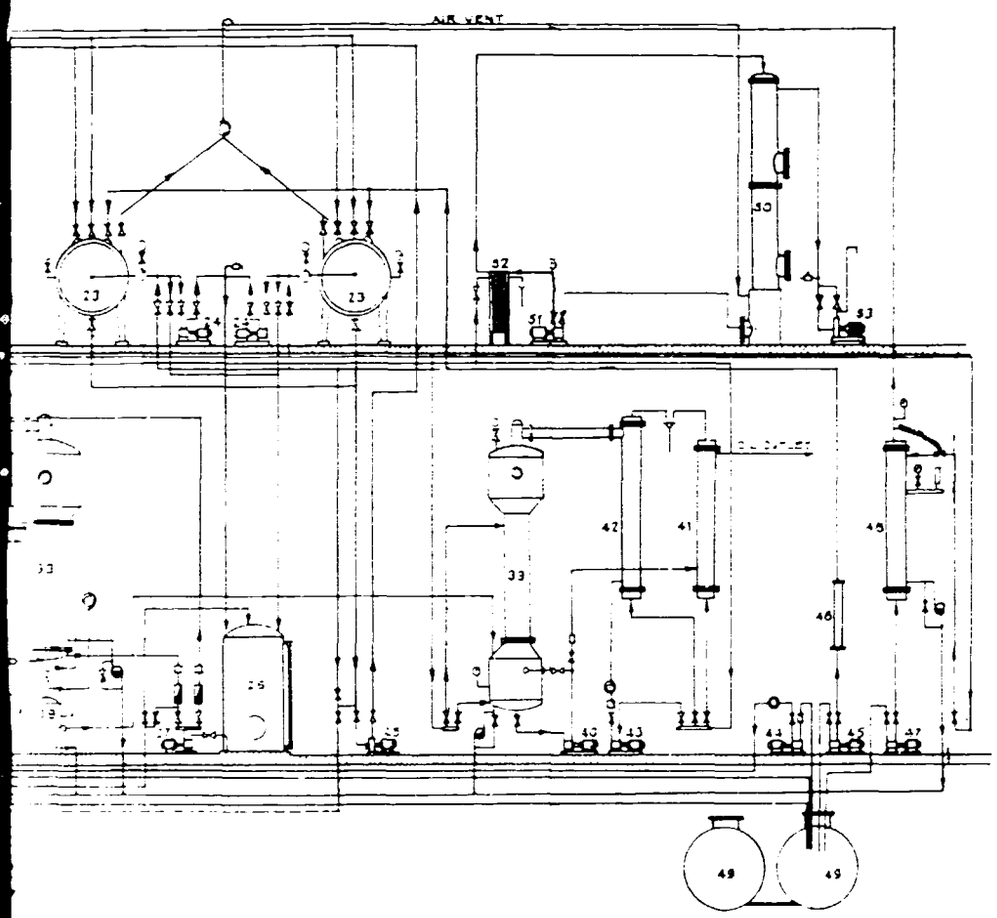


LEGEND FOR DIREZ SOLVENT EXTRACTION PLANT (CMB)

1. PERCOLATION EXTRACTOR
2. MISCELLA RECIRCULATING PUMP
3. MISCELLA PUMP
4. MISCELLA HEATER
5. SOLVENT-TIGHT CONVEYOR
6. SEALED FLAKER
7. SEALED ELEVATOR
8. IMMERSION EXTRACTOR
9. OUTFEED SCREW CONVEYOR
10. DRAINAGE ELEVATOR
11. ROTARY VALVE
12. DESOLVENTIZER - TOASTER
13. OUTFEED SCREW CONVEYOR
14. VAPOUR SCRUBBER
15. GAS-FIER
16. GAS-FIER PUMP
17. BOILER
18. CONDENSER
19. STEAM ECONOMIZER
20. CONDENSER
21. DEPHLEGMATOR
22. BASKET FILTER
23. ROTARY FILTERS
24. FILTER PUMP
25. SLUDGE PUMP
26. MISCELLA TANK
27. MISCELLA PUMP
28. CONDENSER
29. HEXANE COLLECTING TANK
30. HEXANE REMOVAL PUMP
31. VACUUM PUMP
32. PRECONCENTRATED MISCELLA PUMP
33. CONTINUOUS DISTILLER
34. CONDENSER
35. WATER - SOLVENT SEPARATOR
36. WATER TANK
37. WATER PUMP
38. TANK
39. STRIPPING COLUMN
40. OIL PUMP
41. OIL COOLER
42. CONDENSER
43. VACUUM PUMP
44. WATER PUMP
45. HEXANE PUMP
46. HEXANE HEATER
47. HEXANE PUMP
48. HEXANE HEATER
49. SOLVENT STORAGE TANK
50. OIL SCRUBBER
51. CONTINUOUS STRIPPER
52. OIL PUMP
53. OIL COOLER
54. CENTRIFUGAL FAN
55. INSTRUMENT PANEL

6.8

COSTRUZIONI MECCANICHE BERNARDINI
VIA DELLA PETRONELLA 00040 POMEZIA(ROME)ITALY

SECTION 3

7. TYPICAL TECHNICAL DATA ON COCONUT OIL EXTRACTION

A. Normal operating conditions from a Full-Press Oil Mill.

1. COPRA BODEGA

a.	Moisture content of copra received -	7 - 16%
b.	Oil content of copra received -	55 - 65%
c.	Particle size of copra received -	3 - 6 cm across
d.	Storage time in Bodega -	10 - 20 days
e.	Moisture content of copra withdrawn to Mill -	7 - 8%
f.	Oil content of copra withdrawn to Mill -	60 - 65%

2. PRE-CRUSHER

a.	Size of copra fed to Pre-Crusher -	3 - 6 cm
b.	Size of crushed copra -	6 - 12 mm

3. HAMMER MILL

a.	Size of copra fed to Hammer Mill -	6 - 12 mm
b.	Size of copra after Hammer Mill -	1.5 - 3 mm

4. PRE-DRYERS

a.	Moisture content of copra entering Pre-Dryer-	6 - 12%
b.	Moisture content of copra after Pre-Dryer -	4 - 5%

5. COOKER

a.	Temperature of copra entering Cooker -	105 - 110°C
b.	Temperature of copra leaving Cooker -	110 - 115°C
c.	Residence time of copra in Cooker -	25 - 30 minutes

6. CONDITIONER

a.	Temperature in Conditioner -	115°C
b.	Residence time of copra in Conditioner -	15 - 20 minutes

7. EXPELLER

a. Moisture content of copra entering Expeller	-	2 - 3%
b. Oil content of copra entering Expeller	-	62 - 68%
c. Size of copra entering Expeller	-	1.5 - 3 mm
d. Temperature of copra entering Expeller	-	115 - 120°C
e. Temperature of oil leaving Expeller	-	95 - 105°C
f. Temperature of cake leaving Expeller	-	90 - 105°C
g. Residual oil content of cake	-	6 - 8%
h. Moisture in cake	-	1 - 2%
i. Thickness of cake	-	10 mm (approx).

8. CAKE COOLER

a. Temperature of cake entering Cooler	-	95 - 105°C
b. Temperature of cake leaving Cooler	-	60 - 65°C

9. SCREENING TANK

a. Foots in oil entering Screening Tank	-	20 - 30%
b. Foots in oil leaving Screening Tank	-	5 - 10%

10. FILTER PRESS

a. Foots in oil entering Filter Press	-	5 - 10%
b. Foots in oil leaving Filter Press	-	Nil
c. Pressure in Filter Press	-	3 - 4 atm

11. CAKE BREAKER (HAMMER MILL)

a. Size of meal leaving Cake Breaker - 75% smaller than 1.5 mm

12. HUMIDIFIER

a. Moisture content of meal entering Humidifier	-	2 - 3%
b. Moisture content of meal leaving Humidifier	-	10 - 12%

13. PELLET MILL

a. Temperature of meal entering Pellet Mill	-	50 - 60°C

b. Temperature of pellets leaving Pellet Mill - 80 - 90°C
c. Moisture content of pellets - 10 - 12%
d. Size of pellets - 10mm diameter by about 12mm

14. PELLET COOLER

a. Temperature of pellets entering Cooler - 80 - 90°C
b. Temperature of pellets leaving Cooler - 60 - 65°C

15. OIL STORAGE TANK

a. Temperature of oil in storage - 30 - 40°C
b. Moisture content on oil in storage - less than 0.2%
c. Color of oil : 6 - 8R, 36-48Y ($5\frac{1}{4}$" cell)

B. Operating Conditions from a Small-Scale Full-Press Oil Mill

a. Moisture content of copra - 8 - 10%
b. Oil content of copra - 60 - 63%
c. Size of copra leaving Crusher - 3 - 6 mm
d. Moisture content of copra leaving cooker - 3 - 4%
e. Oil content of cake leaving first expeller - 18 - 22%
f. Oil content of cake leaving 2nd Expeller - 9 - 12%

C. Normal Operations Data from a Pre-Press/Solvent Extraction Plant

1. COPRA BODEGA

a. Copra received : Moisture content - 7 - 10%
Oil Content - 55 - 65%
Particle size - 3-6 cm. (across)

b. Storage Period : 2 - 4 weeks

c. Copra withdrawn from Bodega to Mill

Mixture content - 7 - 8%
Oil content - 60 - 65%

2. PRE-CRUSHER

a. Size of copra feed	-	3 - 6 cm
b. Size of crushed copra	-	6 - 12 mm

3. HAMMER MILL (GRINDER)

a. Size of copra feed	-	6 - 12 mm
b. Size of ground copra	-	1.5 - 3 mm

4. PRE-DRYER

a. Moisture content of copra entering	-	7 - 8%
b. Moisture content of copra leaving	-	4 - 5%

5. COOKER

a. Temperature of copra entering	-	85 - 100°C
b. Temperature of copra leaving	-	105 - 115°C
c. Residence time - 20 - 30 minutes		

6. CONDITIONER

a. Temperature of copra entering	-	105 - 115°C
b. Temperature of copra leaving	-	115 - 120°C
c. Residence time - 15 - 20 minutes		

7. EXPELLER

a. Oil content of copra entering	-	60 - 65%
b. Moisture content of copra entering	-	2 - 3%
c. Size of copra entering	-	1.5 - 3 mm
d. Temperature of copra entering	-	115 - 120°C
e. Temperature of oil leaving expeller	-	90 - 100°C
f. Temperature of cake leaving expeller	-	90 - 100°C
g. Residual oil in cake	-	16 - 20%
h. Moisture in cake	-	2 - 4%
i. Thickness of cake	-	12 - 15 mm

8. CAKE COOLER

a. Temperature of cake entering	-	90 - 100°C
b. Temperature of cake leaving	-	60 - 65°C

9. CAKE BREAKER (GRANULATOR)

a. Size of cake entering	-	5 - 25 mm
b. Size of cake leaving	-	2 - 5 mm

10. EXTRACTOR

a. Size of cake entering	-	2 - 5 mm
b. Oil content of entering cake	-	16 - 20%
c. Extraction temperature	-	50 - 55°C
d. Number of stages	-	6 - 10
e. Oil content of extracted cake	-	0.5 - 2%
f. Oil content in miscella	-	10 - 15%
g. Solvent to feed ratio	-	1 - 1.5

11. MISCELLA EVAPORATOR

a. Evaporation temperature	-	100 - 120°C
b. Residual content in oil leaving	-	0.5 - 1.0%

12. OIL STRIPPER

a. Stripping temperature	-	110 - 120°C
b. Solvent content in stripped oil	-	nil

13. DESOLVENTIZER - TOASTER (D-T)

a. Solvent in entering meal	-	40 - 60%
b. Solvent in desolventized meal	-	nil
c. Temperature in D-T	-	110 - 120°C

14. MEAL COOLER

a. Temperature of meal entering	-	110 - 120
b. Temperature of meal leaving	-	50 - 60°C

15. HUMIDIFIER

a. Moisture content of meal entering	-	2 - 3%
b. Moisture content of meal leaving	-	10 - 12%

16. PELLET MILL

a. Temperature of meal entering pellet mill	-	40 - 50°C
b. Moisture content of pellets	-	10 - 12%
c. Oil content of pellets	-	0.5 - 2%
d. Size of pellets	-	10 - 12 mm

17. STORAGE TANK

a. Temperature of oil	-	30 - 40°C
b. Moisture content	0.2% or less	
c. Color of oil	6 - 8R 36-48Y ($5\frac{1}{4}$" cell)	

D. Performance Data from Different Types of Extraction Plants

1. FULL-PRESS PROCESS (Large-Scale and 2-stage Medium-Scale)

a. Raw Materials

Oil content	-	62 - 65%
Moisture content	-	6 - 8%

b. Finished Products

Oil in cake	-	6 - 8%

Moisture in oil - not more than 0.2%

Color of oil - 6 - 8R 36-48Y ($5\frac{1}{4}$" cell)

c. Utilities per metric ton of copra

Steam, 6 atm	-	100 -	150 kg.
Electricity	-	120 -	140 kwh
Water	-	3 -	cu.m.

d. Extraction

Oil yield	-	60 - 63%
Cake yield	-	37 - 40%

2. PRE-PRESS SOLVENT PROCESS (Large and Medium Scale)

a. Raw materials

Oil content	-	62 - 65%
Moisture content	-	6 - 8%

b. Finished products

Residual oil in cake	-	0.5 - 2.0%
Color of oil	-	6 - 8R 36-48Y ($5\frac{1}{4}$" cell)
Moisture in oil	-	not more than 0.2%

c. Utilities

Steam	-	450 - 550 kg per metric ton of copra
Electricity	-	70 - 90 kwh per metric ton of copra
Water	-	10 - 15 cu.m. per metric ton of copra
Solvent make up	-	0.5 - 1% of pre-press cake feed.

d. Extraction

Oil recovery	-	61.5 - 64.5% of copra
Meal recovery	-	36 - 32% of copra

3. FULL-SOLVENT PROCESS (Large and Medium Scale)

a. Raw Materials

Oil Content	-	62 - 65%
Moisture content	-	6 - 10%

b. Finished Products

Residual oil in cake	-	0.5 - 2.0%
Color of oil	-	6 - 7R 36-48Y ($5\frac{1}{4}$" cell)
Moisture in oil	-	not more than 0.2%

c. Utilities

Steam	-	600 - 650 kg per metric ton copra
Electricity	-	45 - 50 kwh per metric ton copra
Water	-	18 - 24 cu.m. per metric ton copra
Solvent make-up	-	0.5 - 1.5% of copra

d. Extraction

Oil recovery - 61.5 - 64.5% of copra
Meal recovery - 36 - 32% of copra

4. FULL-PRESS SMALL SCALE PLANT

a. Raw Materials

Oil content	-	60 - 63%
Moisture content	-	8 - 10%

b. Finished Products

Oil in cake	-	9 - 12%
Moisture in cake	-	3 - 5%
Moisture in oil	-	not more than 0.5%
Color of oil	-	6 - 8R, 36-48Y ($5\frac{1}{4}$" cell)

c. Utilities

Power - 80 - 100 kwh per ton of copra
Steam - 200 - 300 kg per ton of copra

d. Extraction

Oil recovery - 55 - 60% of copra
Meal recovery - 40 - 35% of copra

8. PARTIAL LIST OF OIL EXTRACTION EQUIPMENT SUPPLIERS

(In alphabetical order)

8.1 FULL-PRESS EXPELLER

1. Anderson IBEC
   19699 Progress Drive, Strongfield, Ohio 44136 USA.

2. Frans Fmuldres
   Stork Amsterdam
   1021 JX Ketelstraat 2, P.O.Box. 3007, Amsterdam Holland.

3. French Oil Mill Machinery Company
   Pique, Ohio, 45356 USA.

4. Fried Krupp
   Harburger Eisen-Und Bronzewerke
   Hamburg 90, West Germany

5. Simon Rosedowns Limited
   Cannon Street, Hull, England

6. United Machinery and Spares LTD. (UMAS)
   New Delhi, India

8.2 PRE-PRESS EXPELLERS

1. Anderson IBEC
   19699 Progress Drive Strongfield, Ohio 44136 USA.

2. Frans Fmuldress
   Stork Amsterdam
   1021 JX Katerstraat 2,
   P.O.Box. 3007, Amsterdam Holland.

3. French Oil Mill Machinery Company
   Piqua, Ohio 45356 U.S.A.

4. Fried Krupp
   Harburger Bisen-Und Bronzewerke
   Hamburg 90, West Germany

5. Masiero Industrial S.A.
   Jau Sao Paulo 218 - 219 Brazil

6. Simon Rosedowns
   Cannon Street, Hull, England

7. United Oil Machinery and Spares LTD (UMAS)
   D - 298 Defence Colony, New Delhi, India

8.3 SOLVENT EXTRACTION EQUIPMENT

1. Christiansen & Meyer
   Hamburg - Harburn Aussenmuhlenweg 10
   West Germany

2. Construzzioni Meccaniche Bernardini, C.M.B.
   00040 Pomezia (Rome) Via Petronella, 2, Italy.

3. Crown Iron Works Co.
   P.O.Box. 1364, 1229 Tyler St. NE
   MPLS Minn. 55440 USA.

4. DE SMET
   265 Avenue Prince Baudouin
   Edegem-Antwerp, Belgium.

5. Dravo Corporation, Chemicals Plants Div.
   One Oliver Plaza, Pittsburg, Pa. 15222 USA.

6. Extraktionstechnik
   Geselschaft Fur Olmuhleneinrichtungen M.B.H.
   200 Hamburg 13, Werderstrasse 29, Germany

7. Fratelli Gianazza S.P.A.
   20025 Legnano (Italian) V. LE
   Cardona 78/84

8. French Oil Mill Machinery Corporation
   Piqua, Ohio, 45356 U.S.A.

9. Fried Krupp Harburger Eisen-Und Bronzewerke
   Hamburg 90, West Germany.

10. H.L.S. LTD Industrial Engineering Company
    P.O.Box. 193 Petah - Tikuah, Israel.

11. Lurgi
    D - 6000 Frankfurt (Main) 2
    Federal Republic of Germany

12. Masiero Industrial SA.
    Jau Sao Paulo 17, 200
    P.O.Box. 218 - 219 Brazil.

8.4 SMALL OIL EXPELLERS

1. Anderson IBEC
   19699 Progress Drive Strongfield, Ohio 44136 USA.

2. China National Machinery Import and Export Corporation,
   Shantung Branch, 82 Fan Hsiu Road,
   Tsingtao, China

3. Frans Fmuldres
   Stork Amsterdam
   1021 JX Ketelstraat 2
   P.O.Box. 3007, Amsterdam, Holland.

4. Hander Oil Machinery Co.
   Cecoco Chuo Baeki Goshi Kaiska
   P.O.Box. 8 Ibaraki City, Osaka Pref.
   Japan

5. Simon Rosedowns Limited
   Cannon Street, Hull, England

6. United Oil Machinery and Spares LTD.
   D - 298 Defence Colony
   New Delhi - 110024, India

Product code CCON 15.07 i
Technology sheet no II / 2

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : FULL-PRESS MECHANICAL EXTRACTION PLANT (DOUBLE-PRESSING) - 4 T COPRA/DAY

2. Uses of finished product : Oil - used in the manufacture of cooking oil and soaps.

Copra Meal - Ingredient for animal feeds.

3. Country of Origin : Philippines

4. Equipment:

4.1. Description of Equipment

1- Beam-type Platform Scale, capacity 0-500 kg. for copra.

1- Copra bin, 4 metric ton capacity, wood construction.

1- Copra Grinder, Hander Hammer-mill, capacity 500 kg per hour. With 3-hp motor drive, hopper and impact bars.

1- Copra Cooker, Hander Scorcher, 4-ft diameter by 12" depth, equiped with paddle-type mixer, discharge gate, and 1-hp motor drive. Heating by Diesel fuel burner, carbon-steel construction.

2- Hander H-54 Expellers, capacity 150 kg copra per hour each, mounted one over the other, equipped with cake breakers, feed hopper, and 7.5-hp motor drives.

1- Cake grinder, locally-made hammer mill, capacity 300 kg per hour, with feed hopper, catch box, and 2-hp motor drive.

1- Meal bin, 4 metric tons capacity, mild steel construction.

1- Platform scale for bagged-cake, beam-type, capacity 500 kg.

1- Bag-closing tool (needle)

2- Settling tank with stationary 20-mesh wire screen, capacity 3 tons of oil each.

1- Filtering pump, double-gear type, 60 psi pressure, capacity 300 liters per hour, with ½-hp motor drive.

1- Filter Press, Hander plate-and-frame filter press, 12" x 12" with 16 frames, flushed plate-type, with 100 liters catch-tank.

1- Oil pump, centrifugal type, 500 liters per hour capacity, with ½-hp drive.

1- Crude oil storage tank, 20 tons capacity, mild steel construction, with oil level glass-gauge.

1- Oil pump, for pumping out oil from storage tank, 30 gpm capacity, centrifugal-type, with 2-hp motor drive, and 20-ft 1-inch hose.

1- Platform scale for weighing oil in drums, beam-type, capacity 500 kg.

1- Drum closing tool for closing 55-gallon steel drums.

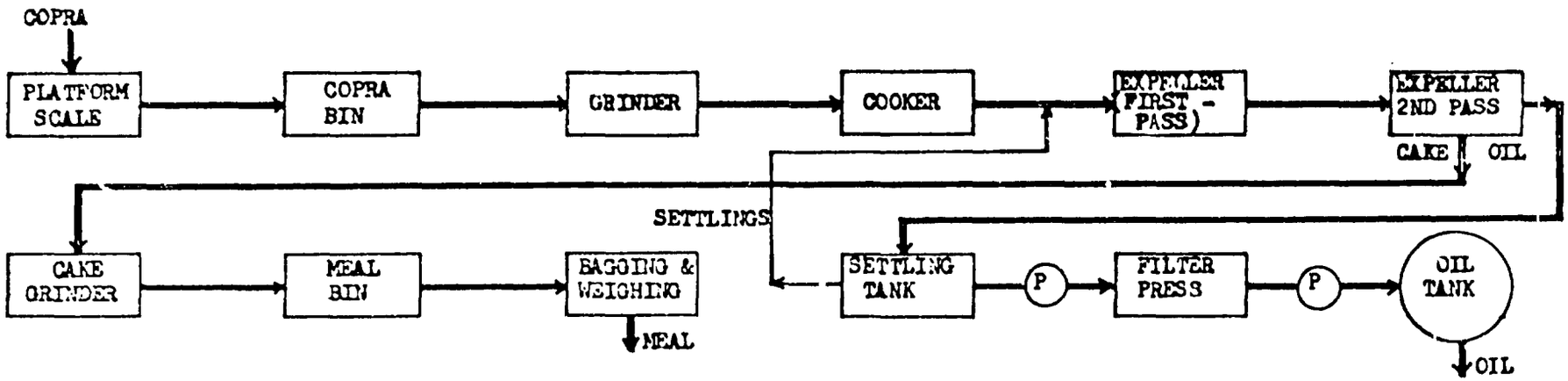
4.2. Materials of construction- Refer to Equipment decription

4.3. Cost of equipment (as listed)-US$ 32,000 (estimate)

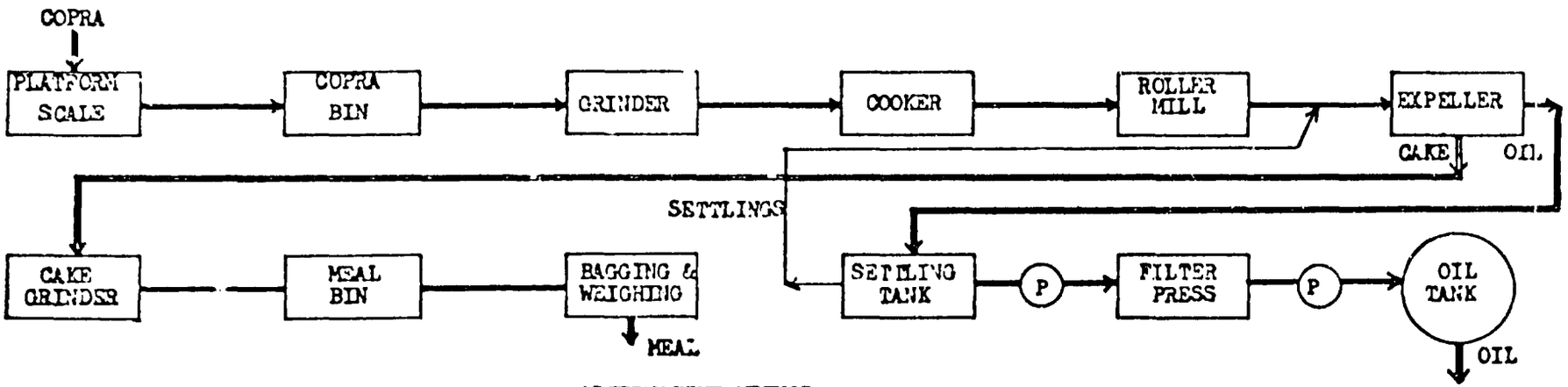
4.4. Capacity- 4 metric tons of copra per 24 hours operation.

5. Process

5.1. Process flow diagram- Refer to attached flow sheet (conventional method)



CONVENTIONAL METHOD



ALTERNATIVE METHOD

PROCESS FLOW DIAGRAMS - SMALL SCALE OIL MILL

5.2. Description of Process:

Delivery and Storage of Copra

In small plants, the copra are delivered in various ways. They are delivered by trucks, jeeps, carts, sledge, on horse back, and even on the shoulder. They are packed in woven sacks of 50 to 100 kilos. An empty space inside the mill serves as copra storage and storage time is normally about a week's supply. Since the copra is well exposed, some drying takes place during the short storage period. Nevertheless, the copra purchased are well controlled for moisture content not more than 10% so that after one week storage the moisture content should fall to about 7-8%.

Copra Transfer and Preparation

The copra is transfered from the storage area to the Bin by wheelborrows. From the bin the copra is fed manually to the grinder. While feeding, the operator picks any metal he finds with the copra. The copra is broken to particles of about 1/16" to 1/4". The ground copra is then fed into a Cooker.

The Cooker is a shallow cylindrical pan with a motor-driven scraper-mixer. Heat is supplied from under the Cooker by a diesel fuel burner. A batch of copra is transfered into the Cooker to about half-full and is cooked for about half an hour or until the copra is "cooked". The cooked copra contains about 3% moisture. At the end of the cooking the discharge gate of the Cooker is opened and the copra is discharged into a container where some cooling takes place before it is fed to the expellers.

Oil Extraction

The two expellers are arranged in vertical series - the cakes from the first are fed directly to the second. They are installed so that one surmounts the other. A box beside the expeller serves as container from where the operator feeds the first expeller by hand at an almost uniform rate. Feeding should be done carefully otherwise the Expeller will choke.

The cakes from the first expeller are broken by a built-in cake breaker then fed into the hopper of the second. The second expeller has a slower speed than the first. The chokes are adjusted for cake thickness of about ¼". With this adjustment the cakes contain about 10-12% oil, after the second espeller. The second expeller is also provided with a cake greaker which grinds the cake into fine particles.

Cleaning and Storage of Oil

The oil from both expellers flow by gravity into a screening ans Settling Tank where the coarse particles are retained by a fixed wire screen and the fines settle at the bottom of the tank. To provide for alternate filling and cleaning, two tanks are used.

The oil from the Settling Tank is decanted by a pump which delivers the oil through the Filter Press. The Filter is installed above a receiving tank so that the filtered oil flow by gravity into the tank. From the receiving tank the oil is pumped to the Storage Tank.

The foots from the settling and the filter cakes are carried back to the expellers where they are mixed with the copra.

Processing and Bagging of Cakes

The ground cakes from the expellers are carried to the Cake Bin where cooling takes place. The cakes are finally scooped into woven bags of 100 pounds weight. The bags are then weighed and sewn. The sacked cakes are stacked 6-high.

5.3. Technical Data

Copra Specifications

Moisture content	8-10%
Oil content	60-65%

Product Yields

Coconut oil 56-60%
Copra cake 34-38%

Power Consumption 60-70 kwh per metric ton of copra

Fuel consumption (diesel) 5-6 liters per ton

6. Quality of finished Products

Coconut oil : Color 6-8R 36-48Y
FFa not more than 3%
Moisture not more than 0.5%

Copra cake : Moisture content 2-5%
Oil content 12-15%
Cake size not bigger than $\frac{1}{4}$"

7. Machinery Supplier: - Hander Oil Machinery and local fabrications.
See technology sheet II / 1 "INTRODUCTION TO MECHANICAL AND SOLVENT EXTRACTION OF COCONUT OIL" for partial list of equipment suppliers.

Product code CCCN 15.07 i
Technology sheet no II / 3

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : FULL-PRESS MECHANICAL EXTRACTION PLANT (ROLL AND PRESS) - 20 T COPRA/DAY

2. Uses of finished product : Oil- used in the manufacture of cooking oil, soap, shortening, and margarine.

Cake- ingredient for animal feeds

3. Country of Origin : Philippines

4. Equipment:

4.1. Description of Equipment

2- Platform Scales, beam-type, capacity 500 kg, 0.1 kg accuracy, for weighing copra in sacks.

1- Copra Bin, 20 metric tons capacity in three compartments, mild steel construction, with bottom conveyor.

1- Copra Pre-Crusher, horizontal, low-speed hammer mill; capacity 1 ton per hour; with hopper, 10-hp motor drive.

2- Copra Grinder, high-speed peg mill, horizontal shaft, with 100-cu.ft hopper, screw feeder, each with 15-hp motor drive; capacity 1 ton per hour each. Used alternately.

1- Roller mill, 3-high, with 3-sets of 10" x 3' rollers, 100-cu.ft. hopper and 7.5-hp motor drive; capacity 1 ton per hour.

2- Expellers, made in the Peoples Republic of China, single worm, 4-high Cooker-Conditioner, vertical feeder, distribution conveyor, overflow bin, return conveyor, each with 25-hp motor drive; capacity 500 kg per hour each.

1- Screening and settling tank, 20-mesh stationary screen on top of the tank, 100-cu.ft. tank with conical bottom, foots withdrawal bottom valve; mild steel construction.

1- Filtering pump, centrifugal, 60 psi, capacity 15 gpm, cast-iron casing, cast iron impeller, graphited asbestos packing, open-impeller type, with 2-hp motor drive.

1- Plate-and-Frame Filter Press, flushed-plate type, open delivery, 24" x 24" with 30 plates and 29 frames, with oil trough, and cake pan.

1- Crude oil storage Tank, 100 tons capacity, cylindrical with conical top, depth gauge, mild steel construction.

1- Cake Grinder, made of ribbon type screw conveyor with rod breakers, 3-hp motor drive.

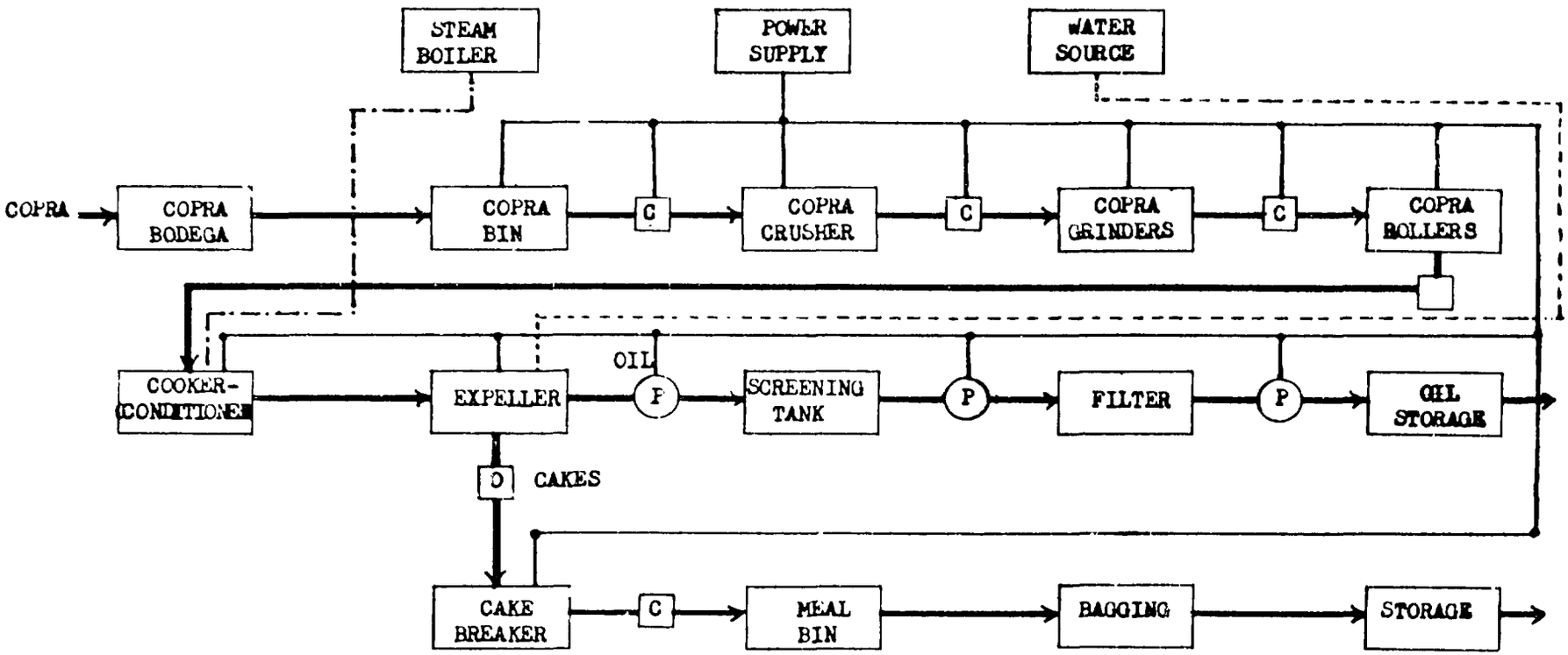
1- Meal Bin, cylindrical with conical, bottom discharge gate, capacity 5 metric tons of cake, mild steel material.

1- Platform scale for weighing cake in bags, capacity 500 kg, beam-type, 0.1 kg accuracy.

1- Platform scale for weighing coconut oil in 55-gal. drums beam-type; capacity 500 kg.

1- Set of conveyors: inclined screw conveyor from Bodega to Copra Bin, transfer screw conveyor from bin to Crusher, rotor-lift from Crusher to Grinder, rotor-lift from Grinder to Roller, horizontal screw conveyor and rotor-lift from Roller to Cooker.

1- Oil transfer pump for pumping oil from filter to Storage Tank, centrifugal type, 60 psi, CI casing and impeller; capacity 15 gpm; with 2-hp motor drive.



PROCESS FLOW DIAGRAM OF A
FULL-PRESS (ROLLER & SINGLE PRESSING) OIL MILL

1- Oil transfer pump for pumping oil out of Storage Tank, capacity 30 gpm, centrifugal, CI material, with 3-hp motor.

1- Set of drum-closing tools to seal 55-gal. steel drums.

4.2. Materials of Construction- refer to equipment description

4.3. Cost of Equipment- US$ 185,000 (estimate)

4.4. Capacity 20 metric tons of copra per 24 hours operation.

5. Process

5.1. Process Flow Diagram- refer to attached Flow Diagram sheet.

5.2. Description of Process;

Delivery and Storage of Copra

The copra are packed in jute sacks and are delivered to the Copra Bodega by trucks. In the Bodega the copra are weighed on platform scales, 4 to 5 sacks at a time. The sacks are opened and the copra is piled on the floor of the Bodega, using a portable inclining screw conveyor. The price of the copra is determined by visual classification.

Copra storage is arranged in lots of about 20 tons Average storage time is about two weeks during which the moisture content of the copra drops to about 7%.

To transfer the copra to the mill, the chosen lot is carted to the hopper of an inclined conveyor which transfers the copra to the Copra Bin in the adjacent mill building. The weight of the copra milled is determined by weighing the copra in the cart.

Copra Preparation and Oil Milling

From the copra bin the copra is conveyed by a belt conveyor to the Copra Crusher. A magnet is installed over the belt conveyor to pick up tramp iron. The crusher breaks the copra to about $\frac{1}{4}$" size. A rotor-lift picks the crushed copra and conveys it to the Copra Grinder. Two Grinders are provided and are operated alternately. The ground copra is very fine, about 14 mesh. The copra is picked again by another rotor-lift and conveyed to the Roller. The Roller converts the copra into thin flakes. The copra flakes are conveyed to the Cooker by a series of a screw conveyor and rotor-lift.

The Cocker-Conditioner heats the copra to about 240°F and reduces the moisture content to about 3% before entering the expeller. Residence time in the Cooker-Conditioner is about 45 minutes.

The Expeller is of a single screw and the shaft is water-cooled to keep the oil content at about 200°F. The choke is adjusted to give 3/8-inch cakes which contain about 10% oil.

Cleaning the Oil

The extracted oil is pumped to the Screening Settling Tank. The larger particles are retained on the screen while foots settle to the bottom of the tank. The foots are withdrawn occasionally through the bottom valve and are recycled to the expeller. The oil is decanted by means of a pump which delivers the oil through the Filter. The filtered oil flows by gravity into a receiving tank from which a pump delivers the oil to the Oil Storage Tank.

The Filter Press is opened priodically for cleaning and dressing. During cleaning periods, the settling tank and the receiving tank serve as surge tanks. The filter cakes are recycled to the Expellers.

Processing and Bagging of Cakes

The cake from the expellers are collected by the Grinding Conveyor. The conveyor has a ribbon screw and peg breakers. Because of the copra preparation, the cakes are weak and easily broken without the use of a mill or grinder, as used in other processes.

At the end of the collecting conveyor the cake particles are conveyed pneumatically to the Cake Bin through a cyclone. The cake is bagged in 100-lb. polyethylene bags and then stacked 6-high in the Copra Cake Bodega. The cakes are stacked on pallets and are spaced to provide air ventillation. The bags should be loosely packed to provide for cake expansion.

5.3. Technical Data:

Copra Specifications

Moisture content	8-12%
Oil content	60-65%

Product Yields

Coconut Oil	58-60%
Copra cake	34-36%

Power consumption 85-100 kwh per metric ton of copra

Steam consumption 100-120 kg per metric ton of copra

Water consumption 3-5 cu.m per ton of copra

6. Quality of Finished Product

Coconut Oil: Color 6-8R 36-48Y
Free Fatty Acid 2-4%
Moisture content not more than 0.2%

Copra Meal : Oil content 10-12%
Moisture content not more than 3%

7. Machinery Supplier - Peoples Republic of China and local fabrications. See technology sheet II/1 "INTPODUCTION TO MECHANICAL AND SOLVENT EXTRACTION OF COCONUT OIL" for partial list of equipment suppliers.

Product code CCCN 15.071
Technology sheet no. II / 4

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Cocomut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : FULL-PRESS MECHANICAL EXTRACTION PLANT 50 T COPRA/DAY

2. Uses of finished product : Oil - used as a raw material in the manufacture of cooking oil, shortening, margarines, soap, glycerine, detergents, surfactants, plasticisers, fatty acid, fatty alcohols.

Copra Meal - ingredient for animal feeds.

3. Country of Origin : Philippines

4. Equipment

4.1 Description of Equipment:

1- Weighbridge, 25 ton capacity, Anderson Model 5984, with cabinet dial and CP-2 ticket printer, two-section straight level Supercast Scale.

1- Set of materials handling equipment for moving copra into the Bodega and from the Bodega to the Mill, consisting of screw conveyors, bucket elevators, rotor-lifts, belt conveyors, drives, motors, and starters.

1- Magnet with rectifier, Anderson Model No.1, with rectangular overhead magnet, cable, and bull ring.

1- Day bin, 2500 cu.ft capacity, of $\frac{1}{4}$" mild steel construction, with live bottom-screw-conveyor discharge, motor drives, and starters.

1- Magnetic separator, Anderson Model (AN-6150-E), complete with high-strength permanent magnet, deflector plate, counter balance, limit switch and alarm bell; take-up pulley, support frame and drive.

1- Vertical Hammer Mill, with 60-hp motor, carbon steel construction. Includes shovel mount and coupling for direct connection to motor. Standard stock hard-faced hammer, sizing screen, and 1½-inch square hole back-up screen.

2- Anderson (AN-181-B) two-High 36" Drying Unit, consisting of single 36" diameter by 13' long dryer vessel, two separate dial indicating thermometers, two manual steam pressure regulators and gauge; two 10-hp totally enclosed motor drives, two steam traps, starters and push buttons.

2- Anderson (AN-2-E) Heavy-Duty Duplex Super Duo Expeller, equiped with: 14" conditioner vessels; three section horizontal drainage barrels, heavy-duty water-cooled main worm shaft; thrust unit, choke unit, vertical shaft, starters for all motors.

1- Overflow bin, 100 cu.ft capacity, mild steel construction.

1- Anderson No. 18 (AN-82-E) Oil Screening Tank, approximately 8' wide x 7.5' high x 16' long, fabricated of carbon steel. Contains a drag conveyor fitted with plates to carry the foots to the screw conveyor after drainage of material; 1-hp motor drive, and a 2-hp oil pump.

2- Heat Exchangers, finned-tube type.

1- Recirculating pump, 150 gpm, with 10-hp motor drive.

1- Unfiltered oil surge tank, 1500 gallon capacity, allsteel construction.

1- Portable Agitator, with 2-hp motor, starter, and push-botton

1- Air compressor, tank-mounted, with 120 gallon air-receiver, 10-hp motor drive, pressure gauge, safety valve, outlet valve, drain valve, automatic start/stop control and starter station.

1- Filter Press, 36" x 36" with 36- 1½" thick chambers, flushed plate and frame type, with ratchet gear closing device.

1- Steam pump, horizontal duplex, 5¼" x 3½" x 6".

1- Hopper and platform, with handrail, and stairs for filter press, all mild steel construction.

1- Oil transfer pump, rotary type, 50 gpm capacity, with 5-hp motor.

1- Set of bagging and weighing equipment, consisting of bagging scale, surge hopper, bag holder; and bag sewing machine.

2- Crude oil storage tanks, each with a capacity of 100 tons of oil, with rain-proof roof, safety ladder, manholes, depth gauge; all made of mild steel.

1- Oil transfer pump for pumping oil from storage tanks, rotary type, 50 gpm capacity, with 5-hp motor drive.

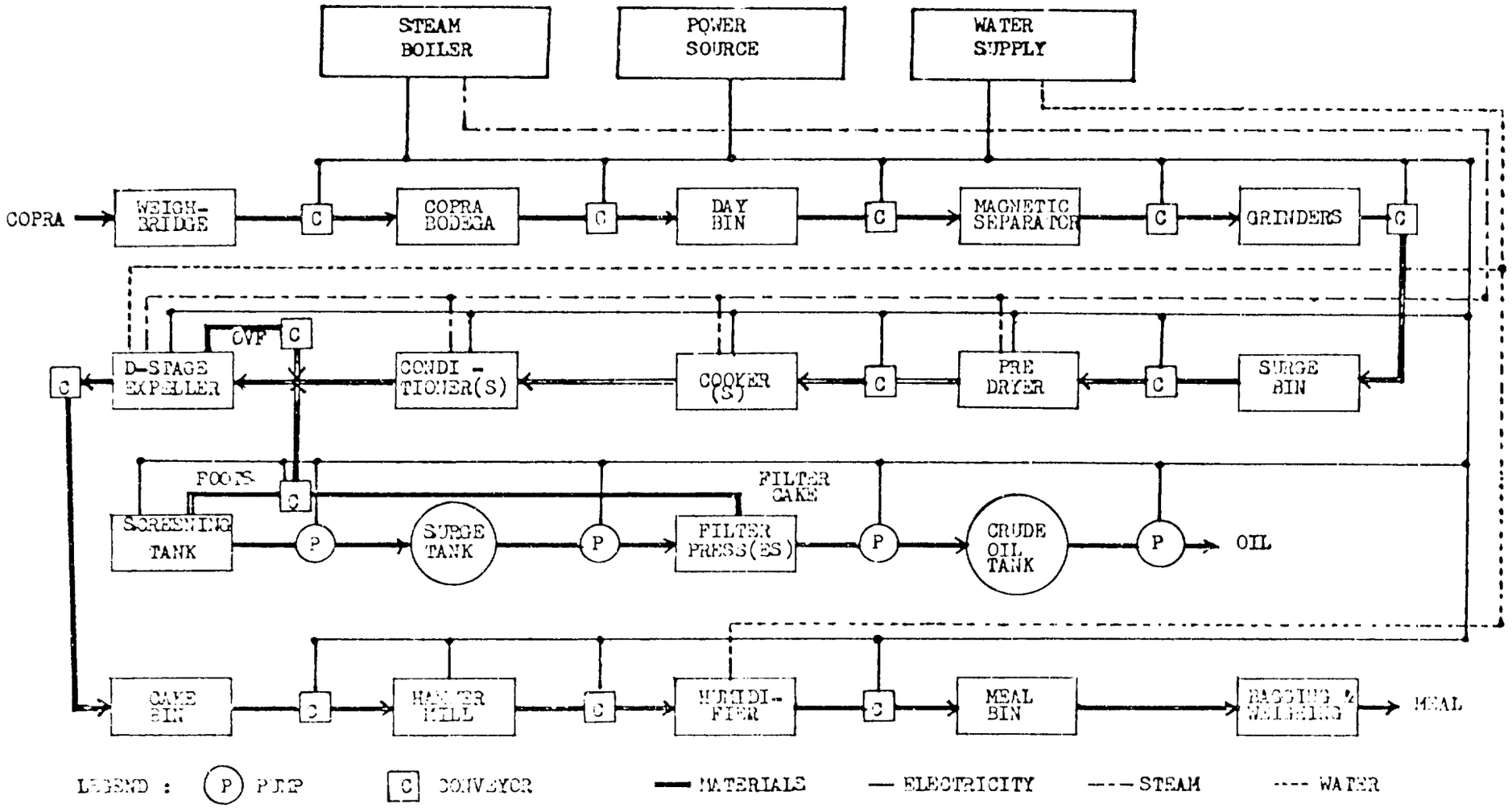
4.2. Materials of construction (Refer to Equipment description)

4.3. Cost of Equipment (as listed) TS$ 720,000 (estimate)

4.4. Capacity 50 metric tons of copra per 24 hours operation

5. Process

5.1. Process flow diagram (Refer to attached Process Flow Diagram)



PROCESS FLOW DIAGRAM
TYPICAL MEDIUM - SCALE OIL MILL

5.2. Description of process:

Delivery and Storage of Copra

Copra is delivered to the Mill in trucks. The weight of each delivery is determined by weight-in minus weight-out through the weighbridge. The final price is based on the classification of the classificador (classifier)

The copra is stored in the bodega by lots based on time of delivery. The copra is stored for a period of two to three weeks, depending of the initial moisture content of the copra received. Copra with the lowest moisture content is withdrawn first for processing in the mill. The copra is transfered to the Day Bin in the Mill by a set of bucket elevator and overhead conveyor.

Copra Preparation and Oil Milling

From the Day-Bin, the copra is conveyed to a bucket elevator from where it is dropped to an inclined shallow through surmounted by the magnets. All tramp irons in the copra are pulled out by the magnets. From the base of the trough, the copra is fed to a vertical hammer Mill which crushes it to fine particles[1/].

The ground copra is passed to a Pre-dryer where the moisture content is reduce to about 5%. The copra is then dropped passed through a Cooker and a Conditioner. This reduces the moisture of the copra to about 3% and conditions the copra for oil extraction by heating for about 45 minutes at a temperature of 240°-250°F[3/].

1/ For medium-scale mills single-stage crushing is used instead of two in large-scale mills.

2/ If the copra from the Bodega can be maintained at 7% moisture, a Pre-dryer can be omitted.

3/ Higher steam pressure is used to effect faster drying.

In the expeller, the copra is subjected to high pressure extraction, first by a vertical worm and then by the main horizontal worm, against the cage-bars. The cake thickness and the residual oil in the cake are controlled by adjusting the choke clearance from the shaft cone. Adjusting the clearance to about 3/8 inch gave cakes with about 7% oil content, under normal operating conditions.

The extraction temperature is kept at about 210°F by water-cooling the main-shaft and spraying of recirculated and cooled oil, over the cage-bars. If the temperature is allowed to rise, dark oil and burnt cakes will be produced. In some case, where the moisture content of the copra is high, high extraction temperature can cause increase in the free-fatty acid content of the extracted oil.

Cleaning of the Oil

The oil from the Expeller flow into the Screening Tank where entrained solids (foots) settle at the bottom. The foots are removed and drained on the screen by a continuous drag conveyor which also convey the drained foots to a conveyor at the tank-end and recycled to expellers.

The screened oil, containing about 5% suspended solids are pumped to the unfiltered oil Surge Tank. From this tank, the oil is cleaned of all suspended solids by filtration through the Plate and Frame Filter Press. The filtered oil is finally pumped to one of the Crude Oil Storage Tanks. After using the Filter for some time, the chambers are filled with cake or the pressure becomes too high. When this happens, the filter is opened and cleaned. The filter cakes are conveyed back to the Expellers to recover the oil.

Oil Storage

Two storage tanks are used-one for measuring oil production while the other is being discharged. This scheme eliminates the need for an oil meter.

It is imporatnt to keep the moisture content of the oil below 0.2% if the oil is to be stored for long periods, otherwise the free fatty acid of the oil will rise.

Processing and Storage of the Cakes

The cakes from the expeller are conveyed to a Cake-Bin where cooling of the cake takes place. From the Bin they are fed to a Cake Grinder which breaks it to fine particles. If they are to be used immediately, the cake can be used in this form. If they are to be bagged for future use, the cakes (meal) have to moistened to about 10% otherwise the bags will break when the meal absorbs water from the atmosphere after some time.

If the cake is sold locally, it is not necessary to pelletize it. However, it will be necessary to provide ventillation for unpelletized cake in storage, otherwise they may burn by spontaneous combustion.

5.3. Technical Data

Raw Material Specification (Copra)

Moisture content of copra	8-10%
Oil content of copra	60-65%

Product Yields

Coconut Oil	62-63%
Copra meal (10% moisture)	32-33%

Power consumption 140-160 kwh per metric ton of copra

Steam consumption 100-120 kg per metric ton of copra

Water consumption 3-5 cu. m. per metric ton of copra

Quality of finished products:

Coconut oil : Color 6-8R 36-48Y
Free Fatty Acid 2-5% as oleic

Copra meal : Oil content 6-7%
Moisture content, unmoistened 2-3%
moistened 10-12%
Particle size 14 mesh (average)

7. Equipment Supplier : Anderson IBEC and Local fabrications

See technology II/I "INTRODUCTION TO MECHANICAL AND SOLVENT EXTRACTION OF COCONUT OIL" for partial list of equipment suppliers.

Product code CCCN 15.07 i
Technology sheet no. II / 5

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Cocomut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : FULL-PRESS MECHANICAL EXTRACTION PLANT
150 T COPRA/DAY

2. Uses of finished product : Oil - used as raw material in the manufacture of cooking oils, shortening, margarines, soaps, glycerine, detergent, surfactants, plasticizers, fatty acids, fatty alcohols.

Copra Meal - mainly used as an ingredient for animal feeds

3. Country of origin : Philippines

4. Equipment :

4.1. Description of Equipment

1- Weighbridge - 30 T capacity, 50' x 10' platform, with ticket printer, two-section straight level scale.

1- Set of materials-handling equipment- for moving copra into the Bodega, and from the Bodega to the Mill, consisting of screw conveyors, bucket elevators, rotor-lifts, belt conveyors, drives, motors and starters.

1- Magnet with Rectifier- Model No. 1 Electric Rectangular overhead magnet with cable suspension and bull ring. Magnet coil wound for 115 volts DC 1570 watts DC required. Coil wound for operation with rectifier. Modal 8S607N Silicon Rectifier for use in energizing the above Model 1 Electro Magnet. For operation on 240/480 volts, DC output 115 volts, 2000 watts NEMA 1 enclosure.

1- Automatic Bulk Weighing Scale - weighing up to 25 tons per hour at 300 pound discharges, of mild steel construction with feeder belt, 26" wide 2-ply rubber belting, self-cleaning head and tail pulleys, manual drop by-pass, spring-loaded belt scraper, 3/4-hp gear motor equipped with brake; scale controls; scale section with weigh beam, weigh hopper, operating weights, and mechanical counter; scale frame of mild steel construction, and motor starter.

1- Vertical Hammer Mill - with 150 hp motor. Carbon steel construction. Includes shovel mount and coupling for direct connection with motor. Standard stock hard-faced hammers, sizing screen and 1 - ½" square hold back-up screen mounted.

6- Anderson AN-180-E single 36" Dryer Unit - consisting of a 36" diameter by 12' long dryer vessel, 10-hp gear motor, dial thermometer, steam traps and motor starter.

6- Anderson (AN-2-E) Heavy Duty Duplex Super Duo Expeller - Equipped with: 14" Conditioner vessel; Three-section Horizontal (33") and long vertical (25-5/8") Drainage Barrels; Heavy duty water-cooled Main Worm Shaft, driven by 50-hp heavy-duty motor; Assembled Vertical Shaft driven by 40-hp heavy-duty motor; Thrust Unit; Choke Unit; and motor starters.

1- Overflow Storage Bin- 100 cubic feet capacity all steel bin, with bottom discharge conveyor, drive motor, and starter.

1- Anderson No. 18 (AN-62-E) Oil Screening Tank - 8 feet 1-3/4 inches wide by 7 feet 5-7/8 inches high by 15 feet 10 inches long, shell fabricated of carbon steel; with drag conveyor fitted with plates designed to carry the foots to the screw conveyor after drainage of material. Equiped with 1-hp motor drive; product oil pump with 2-hp motor; and motor starters.

6- Heat Exchangers- finned type.

1- Circulating oil Pump - 250 gpm capacity, rotary type, with 20-hp motor drive and starters.

1- Unfiltered Oil Tank - 2000 gallons capacity, all steel construction.

1- Portable agitator - with 3-hp motor, for unfiltered oil tank.

2- Filter Presses - 36" x 36" plate and frame filter press, flush plate and frame type, with 42 chambers, for forming cake 1-½" thick, with rachet gear closing device.

1- Hopper and Platform - with handrail and stairs for two filter presses; with discharge conveyors, motors and starters.

1- Steam Pump- horizontal duplex, size 6 x 4 x 6 with ball valves.

1- Air Compressor - two-stage, two cylinder, horizontal tank mounted; with 120 gallon air receiver, 10-hp motor, pressure gauge, safety valve, automatic stop-start control, outlet valve, drain valve, and starter with pushbutton.

1- Filtered Oil Tank - 2000 gallons capacity, all steel construction.

1- Rotary Oil Transfer Pump- capacity 90 gpm against 20 psi, with 5-hp motor and starter.

1- Vegetable Oil Meter- with straight reading dial calibrated in liters, automatic temperature compensating unit, air release assembly, spring-loaded check valve.

1- Anderson (AN-195-E-ST) Single Rotary Cake Cooler- pan and cooler cover made of type 304 stainless steel, carbon steel access doors and air inlet ducts; with 5-hp motor and starter.

1- Mill Exhauster- for cake cooler; with fan, cyclone and 5-hp motor and starter.

1- Cake Grinder- furnished with 3 screens, feed inlet chute with permanent magnet; 50-hp motor and starter; 3 tons per hour capacity

1- Humidifying Conveyor- 3 tons per hour capacity, with high pressure water spraying nozzles and water pump with 1-hp motor.

1- California Pellet Mill for 3/8" pellets, with 100-hp main drive, 3/4-hp feeder drive, permanent magnet; 3 tons capacity per hour.

1- Pellet Cooler, with Exhaust Fans and 20-hp motor drive.

1- Set Bagging and Weighing Equipment- automatic with hopper, gross scale; capacity 8000 pounds per hour in 100-lb. weigh-outs.

1- Set of conveyors, bucket elevators, rotor lifts, for moving copra and copra meal from one equipment to another within the plant.

2- Bulk Oil Storage Tanks- each 500 metric tons capacity, 33 feet diameter by 24 feet high; mild steel construction, with conical cover, manholes, safety ladder, depth gauge.

1- Crude Oil Pump- rotary type, 250 gpm capacity; with 15-hp motor and starter.

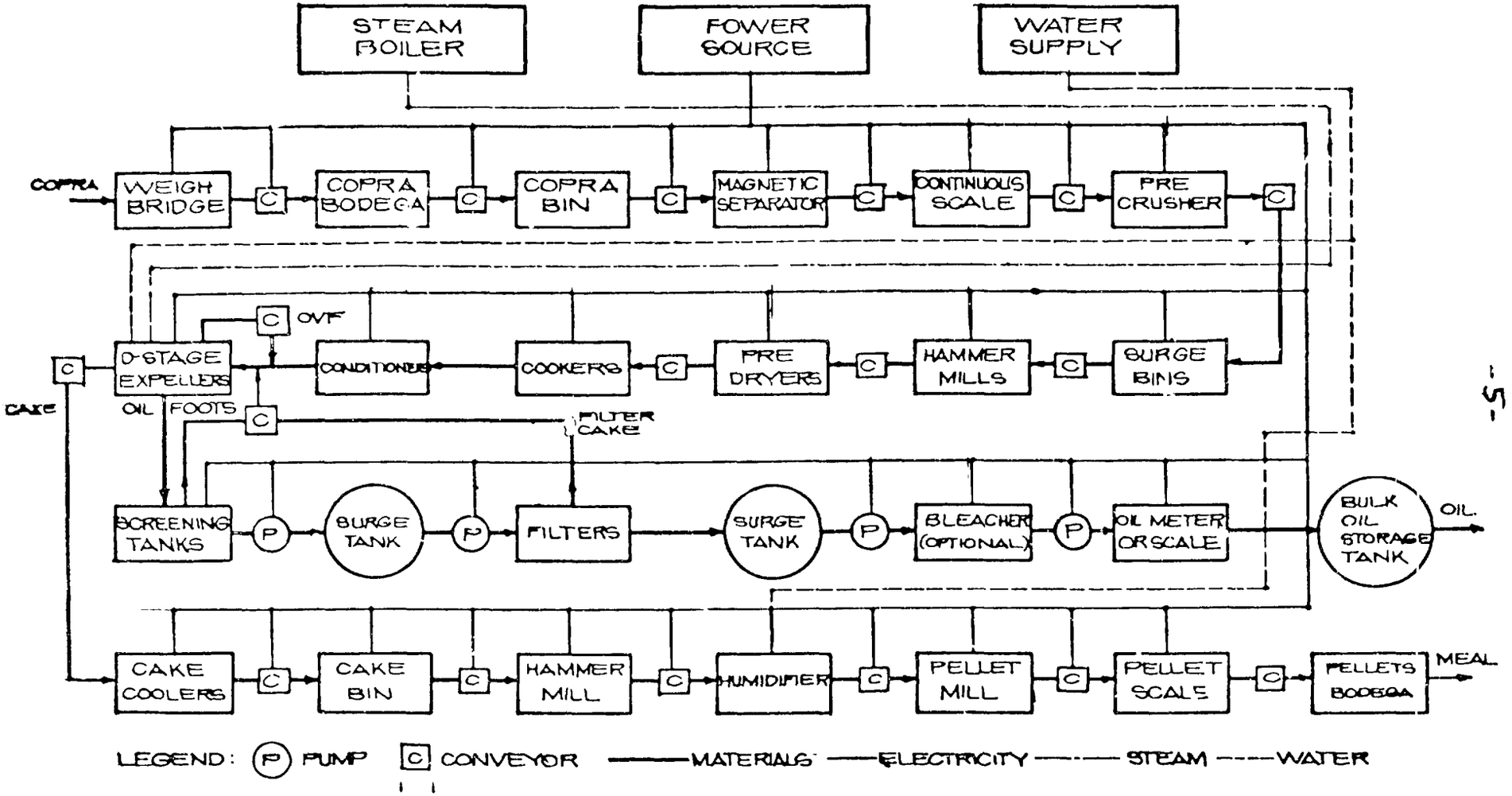
4.2. Materials of Construction- Refer to equipment description.

4.3. Cost of equipment (estimate)- US$ 2,350,000 F.O.B.

4.4. Capacity- 150 metric tons of copra per 24 hours operation.

5. Process :

5.1 Process flow diagram (See attached)



PROCESS FLOW DIAGRAM

TYPICAL LARGE SCALE OIL MILL

5.2 Description of Process:

Delivery and Storage of Copra

Copra is delivered to the Copra Bodega in trucks. Weight of each delivery is determined by weigh-in and weigh-out through the weighbridge. The final price of the copra is based on the quality as determined by the classifier and laboratory analysis.

Copra is transferred to the bodega by first opening the copra bags, emptying the copra into the receiving conveyor, lifting the copra by a bucket elevator into an overhead conveyor in the Bodega, and finally dropping the copra through a movable chute. The copra is distributed on the bodega floor by lots to provide for first-in first out withdrawal of copra for delivery to the mill. Storage time is from 15 to 30 days.

Copra Transfer and Preparation

The copra is transferred from the bodega to the mill by a series of floor conveyors, rotor-lift, and overhead conveyors. At the mill the copra is received in the Day Bins, from the bottom of the bins, the copra is conveyed through the Magnetic Separator, where the tramp iron mixed with the copra are pulled out by the magnets. If not removed, the metals will damage the hammer mills and expellers. The copra throughput is measured by a continuous weighing scale in line with the conveyor.

The copra is broken into fine particles by a high speed vertical hammer mills. The copra particles leaving the grinders are about 1/16" to 1/8" in size.

The crush copra, which has about 6% moisture, is passed through a Pre-Dryer where the moisture content is reduced to abc[illegible] 4%. From the Pre-Dryer the copra drops into the Cooker.

The Cooker brings the temperature of the copra to the conditioning temperature of about 220°F. At the Conditioner the copra is maintained at about 220°-230°F for about 30 minutes. This will insure uniform heat penetration into the copra before oil extraction. The moisture of the copra drops down to about 3% as it passes through the Cooker and Conditioner.

Oil Extraction

In the Expeller the copra is subjected to high pressure oil extraction, first by a vertical screw, and finally a horizontal main screw. The oil extraction efficiency and the thickness of the cakes are controlled by a choking mechanism at the discharge-end of the main screw. The normal setting of the choke is for 3/8" to ½" cakes. With this setting the oil content in the cake is kept at about 7%. To control the temperature during extraction, the main shaft is provided with water cooling, and cooled oil is sprayed over the screw cage bars. The temperature of the oil should be kept at about 200°-215°F to produce light colored oil and effect good extraction.

Cleaning and Storage of Oil

The oil extracted in the Expellers flow into the Screening Tanks, to remove the entrained foots from the oil. At the Screening Tank, the foots settle at the bottom and are continuously scooped out by a series of chain-mounted scrapers which lift the foots to the screen on top of the tank. While travelling across the screen, oil is drained out of the foots. The foots leaving the Screen are conveyed back and mixed with the copra entering the Expeller. Screening reduces the solids content of the oil to about 10%.

From the Screening Tank the oil is pumped to a Surge Tank. The solids in the oil are kept in suspension while in the tank by means of a stirrer. To remove the solids left in the oil it is passed through the filters. Two filters are provided- one on duty while the other is being cleaned and dressed. Maximum filter-

ing pressures reach about 60 ps. When the filters are filled, they are opened, and the filter cakes are recycled to the expellers. The filtered oil flow into a filtered oil surge tank from where the oil is finally pumped to the Coconut oil Storage Tanks. The oil output is measured by an in-line Oil Meter.

The oil in storage should be kept at low temperatures (about 80-100°F) and the moisture content should be kept at maximum of 0.2% for long storage periods.

Processing the Cakes

The cakes which leave the expellers at about 200°F are cooled down to about 140°F by a Cake Cooler. The cooling prevents the darkening or burning of the cake in storage and conditions the cake for grinding.

The cakes are ground to fine particles by a Hammer Mill, moistened to about 10-12% moisture by spraying water into the cake as it passes through the humidifying conveyor, and then fed to the Pellet Mill. Increasing the humidity of the cake is necessary for effective pelletizing and to meet shipping regulations. For exports, the pellet size is 3/8-in in diameter and an average of about ½-inch.

The pellets are cooled down in a Pellet Cooler and then conveyed to the Pallets Bodega where it is stored in bulk. Some of the pellets are bagged for domestic sales. Pellets for bagging are packed in woven poly-propylene bags using the Bagging and Weighing EQuipment.

Pellets are safer to store and easier to handle. It is important to keep the oil content, moisture content, and temperature of copra cake and copra meal pellets when in storage and during shipment. They can be fire hazzards. It is a good rule not to store unpelletized copra cake in bulk.

5.3 Technical Data

Raw Material Specification (Copra)

Moisture content as received in the Bodega	8 - 16%
Moisture content as received in the Mill	7 - 8%
Oil Content as received in the Bodega	58 - 65%
Oil Content as received in the Mill	60 - 65%

Product Yields

Coconut oil	60-63% of copra delivered to Mill
Copra meal with 10% moisture content	32 - 33%

Power Consumption 120-120 kwh per ton of copra at 100 psi.

Steam Consumption 100-120 kg per ton of copra at 100 psi.

Water Consumption 3-5 cu.m. per ton of copra

6. Quality of Finished Products

Coconut oil : Color 6-8R, 36-48Y (5¼" cell)
FFA 2-5% as Oleic
Moisture not more than 0.2%

Pellets : Moisture content 10-12%
Oil content 6-7%
size 3/8 inch diameter

7. Machinery Supplier : Anderson IBEC

See technology sheet II/1 "INTRODUCTION TO MECHANICAL AND SOLVENT EXTRACTION OF COCONUT OIL" for partial list of equipment suppliers.

Product code COCN 15.07 1

Technology sheet no. II / 6

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : FULL-PRESS MECHANICAL EXTRACTION PLANT 250 T COPRA/DAY

2. Uses of finished product : Oil- used as raw material in the man facture of cooking oils, shortening, margarines, soap, glycerins, detergents, surfactants, plasticizers, fatty acids, fatty alcohols.

Copra Meal- Mainly used as ingredient for animal feeds.

3. Country of Origin : Philippines

4. Equipment:

4.1. Description of Equipment

1- Weighbridge, 30 T capacity, 50' x 10' platform, ticket-printer, 0.10 kg accuracy.

1- Set of screw conveyors and elevators to transfer copra from receiving station to copra bodega, mainly of mild steel.

1- Set of conveyors and elevators to transfer copra from bodega to the copra bin, made mainly of mild steel.

1- Copra bin, 12,000 cu.ft capacity, with bottom discharge screw conveyor, made of mild steel.

1- Set, Magnetic Separator assembly, consisiting of copra spreader, electro-magnet, and permanent magnets.

1- Automatic bulk-weighing scale, 12 T per hour capacity with feeder and catch gate.

2- Horizontal swing hammer mill , each with a capacity of 6-7 tons per hour, 25-hp drives, and 5/8-in. screens.

1- Copra Surge bin, 10 ton capacity, made of steel.

4- Vertical Hammer Mills, Enterprise, 10-mesh heavy-duty screens, each with 75-hp motor drives.

10- Dryer/Cooker units, 36" diameter by 12' long, each with 10-hp motor drive.

10- Expellers, Anderson Heavy-Duty Duplex Super Duo, equiped with 14" conditioner vessels, each with 100-hp motor drives.

2- Overflow bins, 100 cu.ft capacity, made of mild steel.

10- Heat exchangers for oil cooling, finned-tube.

2- Screening Tanks, 8' wide x 7.5 high x 16' long, each with 1-hp motor drive, and 2-hp oil pump.

1- Surge tank for unfiltered oil, 1,500 gal capacity and 2-hp stirrers.

2- Oil pumps for recirculating oil to expellers, rotary type, each 300 gpm capacity and with 25-hp drive.

2- Filtering pumps, horizontal duplex steam pumps, 5¼" x 3¼" x 6", 2-cylinders.

2- Plate and Frame Filter Presses, 36" x 36" with 1½" chambers. Open-delivery type, with catch pans for oil and cakes.

1- Surge tank for filtered oil, 2,500 gallon capacity, made of mild steel.

1- Oil transfer pump, rotary type, 100 gpm capacity, with 10-hp motor drive.

1- Vegetable oil meter, cumulative-type, with automatic temperature compensating adjustment.

2- Bulk oil storage tanks, each 1000 tons capacity, 46' diameter and 25' high, with conical roof, mild steel.

2- Two-high cake coolers, with fans, each with 5-hp motors.

1- Cake bin, 650 cu.ft capacity, with bottom screw conveyor. Made of mild steel.

1- Hammer mill for grinding cakes, 5 tons per hour capacity with permanent magnet and 75-hp motor drive.

1- Humidifying conveyor with water spraying device and water pump.

2- California Pellet Mills, for 5/8" pellets, with 100-hp main drives, 3/4-hp feeder drives, 4 tons per hour capacity.

2- Pellet Coolers, with exhaust fans, and 20-hp drives.

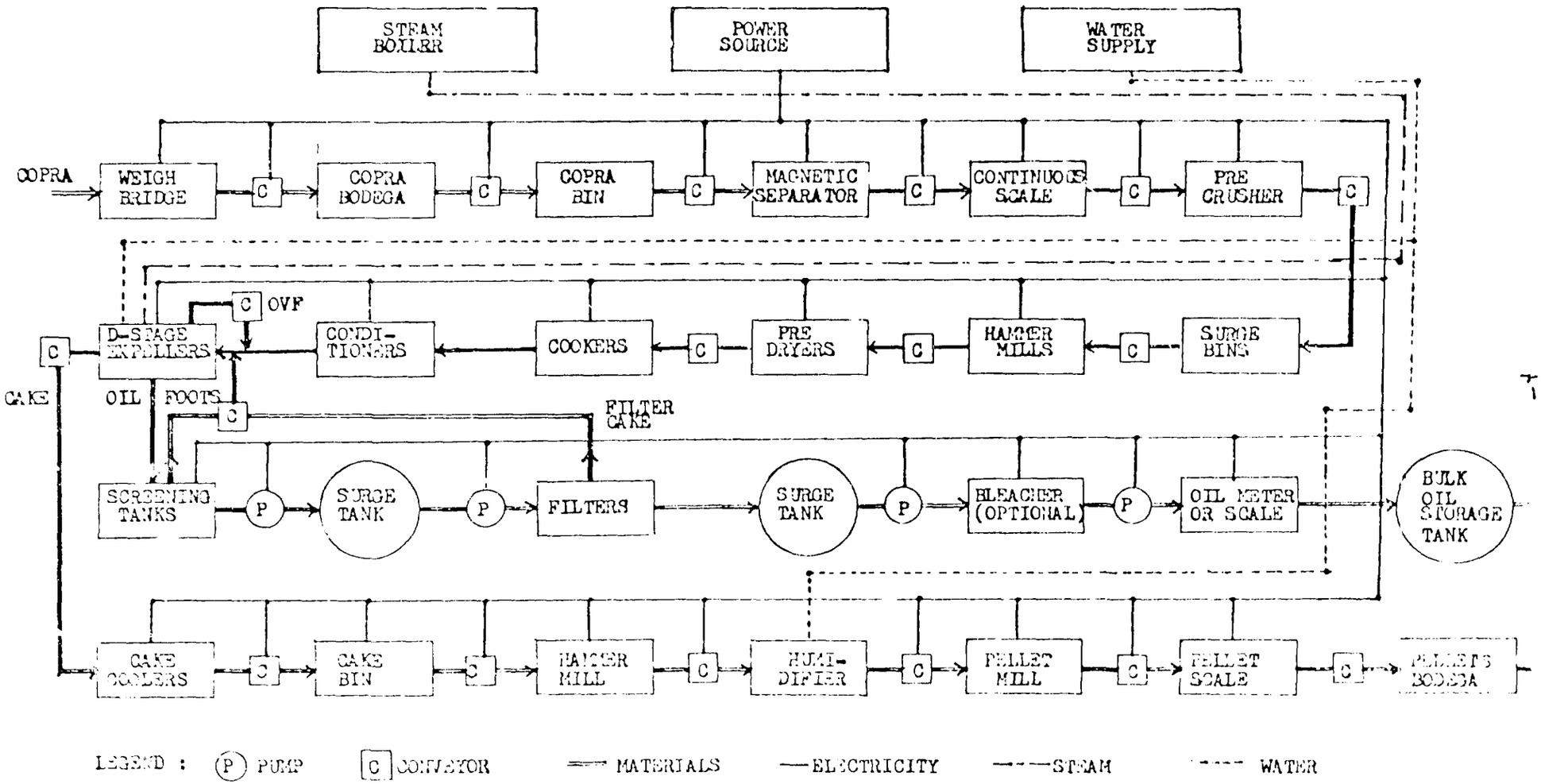
1- Set Bagging and Weighing Equipment, automatic, with hopper, gross scale, capacity- 8000 pounds per hour in 100-lb. weighouts.

Several conveyors, bucket elevators, rotor-lifts for moving copra and copra cakes from one equipment to another in the mill.

4.2. Materials of construction- Refer to equipment descriptions.

4.3. Cost of Equipment (as listed)- US$ 3,390,000

4.4. Capacity 250 metric tons of copra per 24 hours of operation.



PROCESS FLOW DIAGRAM
TYPICAL LARGE SCALE OIL MILL

5. Process

5.1. Process Flow Diagram (See attached flow diagram)

5.2. Description of Process:

Delivery and Storage of Copra

Copra is delivered to the Copra Bodega in trucks. The weight of each delivery is determined by weigh-in and weigh-out through the weighbridge. The final price of the copra is based on the quality as determined by the classifier and laboratory analysis.

Copra is transfered to the bodega by first opening the copra bags, emptying the copra into the receiving conveyor, lifting the copra by a bucket elevator into an overhead conveyor in the Bodega, and finally dropping the copra through a movable chute. The copra is distributed on the bodega floor by lots to provide for first-in first out withdrawal of copra for delivery to the mill. Storage time is from 15 to 30 days.

Copra Transfer and Preparation

The coprs is transfered from the bodega to the mill by a series of floor conveyors, rotor-lift, and over-head conveyors. At the mill the copra is received in the Day Bins, from the bottom of the bins, the copra is conveyed through the Magnetic Separator, where the tramp iron mixed with the, copra are pulled out by the magnets. If not removed, the metals will damage the hammer mills and expellers. The copra throughput is measured by a continuous Weighing Scale in line with the conveyor.

The copra is broken into fine particles by a series of sets of hammer mills- the first set consisting of low-speed high capacity horizontal hammer mills, and the second set consisting high speed vertical hammer mills. The copra particles leaving the grinders are about 1/16" to 1/8" in size. This arrangement results in more uniform grind and low temperature grinding.

The copra, which has about 6% moisture at this stage, is passed through a Pre-Dryer where the moisture content is reduced to about 4%. From the Pre-Dryer the copra drops into the Cooker. The Cooker brings the temperature of the copra to the conditioning temperature of about 220°F. At the Conditioner the copra is maintained at about 220°-230°F for about 30 minutes. This will insure uniform heat penetration into the copra before oil extraction. The moisture of the copra drops down to about 3% as it passes through the Cooker and Conditioner.

Oil Extraction

In the Expeller the copra is subjected to high pressure oil extraction, first by a vertical screw, and finally a horizontal main screw. The oil extraction efficiency and the thickness of the cakes are controlled by a choking mechanism at the discharge-end of the main screw. The normal setting of the choke is for 3/8" to ½" cakes. With this setting the oil content in the cake is kept at about 7%. To control the temperature during extraction, the main shaft is provided with water cooling, and cooled oil is sprayed over the screw cage bars. The temperature of the oil should be kept lower than 200°F otherwise a dark-colored oil is produced.

Cleaning and Storage of Oil

The oil extracted in the Expellers flow into the Screening Tanks, to remove the entrained foots from the oil. At the Screening Tank, the foots settle at the bottom and are continuously scooped out by a series of chain-mounted scrapers which lift the foots to the screen on top of the tank. While traveling across the screen, oil is drained out of the foots. The foots leaving the Screen are conveyed back and mixed with the copra enetring the Expeller. Screening reduces the solids content of the oil to about 10%.

From the Screening Tank the oil is pumped to a Surge Tank. The solids in the oil are kept in suspension while in the tank by means

of a stirrer. To remove the solids left in the oil is passed through the filters. Two filters are provided- one on duty while the other is being cleaned and dressed. Maximum filtering pressures reach about 60 psi. When the filters are filled, they are opened, and the filter cakes are recycled to the expellers. The filtered oil flow into a filtered oil surge tank from where the oil is finally pumped to the Coconut Oil Storage Tanks. The oil output is measured by an in-line Oil Meter.

The oil in storage should be kept at low remperatures (about 80-100°F) and the moisture content should be kept at maximum of 0.2% for long storage periods.

Processing the Cakes

The cakes which leave the expellers at about 200°F are cooled down to about 140°F by a Cake Cooler. The cooling prevents the darkening or burning of the cake in storage and conditions the cake for grinding.

The cakes are ground to fine particles by a Hammer Mill, moistened to about 10-12% moisture by spraying water into the cake as it passes through the humidifying conveyor, and then fed to the Pellet Mill. Increasing the humidity of the cake is necessary for effective pelletizing and to meet shipping regulations. For exports, the pellet size is 3/8-in in diameter and an average length of about ½-inch.

The pellets are cooled down in a Pellet Cooler and then conveyed to the Pellets Bodega where it is stored in bulk. Some of the pellets are bagged for domestic sales. Pellets for bagging are packed in woven polyethylene bags using the Bagging and Weighing Equipment.

Pellets are safer to store and easier to handle. It is important to keep the oil content, moisture content, and temperature of copra cake and copra meal pellets when in storage and during

shipment. They can be fire hazzards. It is a good rule not to store unpelletized copra cake in bulk.

5.3. Technical Data

Raw Material Specifications (Copra)

Moisture content as received in the Bodega	8-16%
Moisture content as received in the Mill	7-8%
Oil Content as received in the Bodega	58-65%
Oil Content as received in the Mill	60-65%

Product Yields

Coconut oil	60-63% of copra delivered to Mill
Copra Meal with 10% moisture content	32-33%

Power Consumption 120-140 kwh per ton of copra at 100 psi.

Steam Consumption 100-120 kg per ton of copra at 100 psi.

Water Consumption 3-5 cu.m per ton of copra.

6. Quality of Finished Products

Coconut oil	:	Color 6-8R, 36-48Y
		FFA 2-5% as Oleic
		Moisture not more than 0.2%
Pellets	:	Moisture content 10-12%
		Oil Content 6-7%
		Size 3/8 inch diameter

7. Machinery Supplier: Anderson IBEC

For other machinery manufacturers, see technology sheet II/1 "INTRODUCTION TO MECHANICAL AND SOLVENT EXTRACTION OF COCONUT OIL" - for partial list of various and adresses.

Product code CCCN 15.07 i

Technology sheet no. II / 7

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : PREPRESS AND SOLVENT EXTRACTION PLANT
150 T COPRA/DAY

2. Used of finished product : Oil- Raw material in the manufacture of cooking oils, shortening, margerine soap, glycerine, detergents, surfactants, plasticizers, fatty acids, fatty alcohols

Meal- ingredient in the blending of animal feeds.

3. Country of Origin : Philippines.

4. Equipment:

4.1 Description of Equipment

Preparation Section

1- Copra cleaner, consisting of shaker with built-in ball cages, feeder, all steel construction, with 2-hp motor.

1- Magnetic separator, drum type.

1- Copra pre-crusher, consisting of crusher with coarse granulating bars, in carbon steel construction, with rotary magnetic separator, 7-½ hp motor and 5 hp motor.

1- Copra disintegrator, cast iron construction, with hardfaced hammers, ½" perforated screen and 75-hp motor drive.

2- FRENCH Model D-88 Dual Cage Screw Press, equiped with water-cooled two-speed shaft, all hard-coated reversible discharge worms and tapered collars, safety-type cone with adjustible cone mechanism. Press is driven by a 200-hp motor.

2- FRENCH 7-high 100" diameter cooker-conditioner, equiped with floating-type gates to control level of material, vent fan, automatic temperature controls, and 60-hp motor drive.

1- FRENCH Size 3, three-pass automatic oil settling tank having three sparate settling chambers, each with continuously running chain with paddles to automatically pick up the foots, carry them across the wedgewire drain board, and discharge the foots into a return conveyor.

2- Plate and frame filter press, 36 inches square with 42 plates, hydraulic closing device.

1- Copra cake granulator for grinding prepressed cake.

1- Set of conveyors for transfering material within the prepressing plant.

3- Pumps: 1-for pumping oil from the settling tank, 1-for filtering. 1-for pumping filtered oil to oil storage tank.

Solvent Extraction Plant - 75 TPD Prepressed Cake

1- Cake conveyor, mass flow type, to elevate the cake from the Granulator to Extractor feed conveyor, with 5-hp motor drive.

1- FRENCH Stationary Basket Extractor, #410, concurrent and countercurrent type, consisting of 12 compartments, a 2-hp feed conveyor, solvent and miscella distribution pipes, sight glasses, variable speed drive, and a picker with 1-hp motor drive. The extractor effective volume is 272 cu.ft.

5- Miscella pumps, each with 2-hp motor drives.

Miscella Evaporation Equipment

1- 1st stage evaporator consisting of a long tube evaporator, with 30 1-¼" OD type 304 stainless steel tubes 15 ft. long, with entrainment separator, automatic level controller and control valve.

1- Final oil stripping column consisting of a final distillation column 14" diameter x 30' high, condenser, and vacuum system.

1- Solvent recovery system consisting of a primary condenser, 30" diameter by 8 ft long, with stainless steel tubes; a condenser 16" diameter by 6 ft long, with stainless steel tubes; a solvent heater, extractor purge fan, and a steam ejector.

1- Final vent solvent recovery system consisting of a 10" diameter mineral oil scrubber, mineral oil stripper, oil cooler, with pumps and instruments.

1- Set of pumps consisting of : solvent pump, pumps for miscella and solvent from vacuum units, finished oil pump, and steam condensate tank and pump.

Removal of Solvent from Cake

1- FRENCH Desolentizer-Toaster for removing all the solvent from the spent meal and to toast it to desired conditions. Composed of a vertical cylindrical column and a stack of steam-jacketed kettles, equiped with live-steam injection and vapor outlet devices, wet dust scrubber to clean vapors leaving the DT.

Pelletizing Plant

1- Meal bin, 800 cu.ft. volume, with discharge gate and bottom conveyor, all mild steel construction.

1- Humidifier unit consisting of a ribbon flight screw conveyor with water spray pipes and ½-hp spray water pump.

2- California Pellet Mills, for 3/8" pellets, each with 100-hp main drives, 3/4 hp feeder drive, each 4 tons per hour capacity.

2- Pellet coolers with exhaust fan and 20-hp drive.

1- Bagging and weighing equipment, automatic with hopper, scale, capacity 80 100-lb bags per hour.

1- Set interconnecting conveyors.

Crude oil Storage

2- Crude oil storage tanks, each 33 ft diameter by 24 ft high, mild steel construction, with conical cover, manholes, safety ladder, and depth gauge, capacity 500 tons each.

1- Crude oil pump, rotary-type, 250 gpm capacity, with 15-hp motor drive.

4.2 Materials of construction - refer to equipment description.

4.3 Cost of equipment (as listed) US$2,200,000

4.4 Capacity 150 metric tons copra per 24 hours operation.

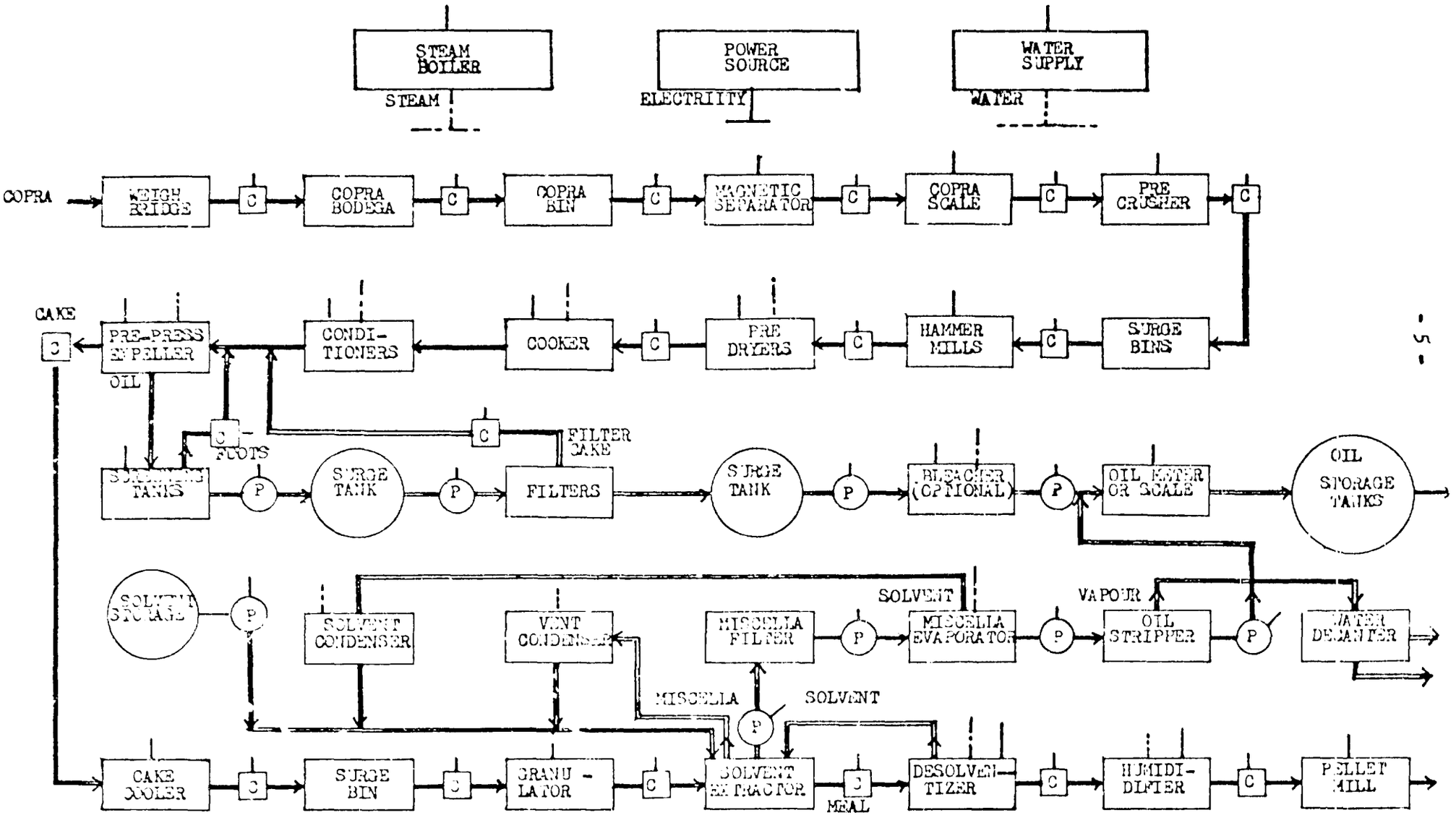
5. Process

5.1 Process Flow Diagram- (See attached flow diagram sheet).

5.2 Description of process.

Delivery and Storage of Copra

Copra is delivered to the bodega in jute sacks by trucks. The weight of the copra is determined by weight-in minus weight-out through the weighbridge. The final price of a copra delivery



PROCESS FLOW - DIAGRAM
MECHANICAL AND SOLVENT EXTRACTION PLANT

is based on classification and laboratory analysis.

Copra is transfered to the Bodega by opening the sacks, emptying the copra into a receiving conveyor, lifting by bucket conveyor into the overhead conveyor inside the bodega, and finally dropping the copra through distribution chutes. Storage time is from 15 to 30 days to allow for drying and moisture equalizing. The copra are withdrawn on first-in first-out schedule.

Copra Transfer and Preparation

The copra is transfered to the Mill by a network of floor conveyors, bucket elevators, and overhead conveyor, into the Copra Bin in the Mill building. A screw conveyor draws copra from the bottom of the Bin and brings it to a spreader where magnets pullout tramp irons mixed with the copra then to the Copra Scale where the copra through-put is weighed.

The copra is crushed into fine particles first by low-speed hammer crushers and then by vertical high-speed hammer mills, resulting in copra fines 1/16" to 1/8 in sizes.

To condition the copra for oil extraction it is passed through Pre-Dryers, Cookers, and Conditioners. This reduces the moisture content to about 3% and brings the temperature to about 240°F.

Oil Extraction - Pre-Pressing

The oil is partially extracted by means of a Screw Press. The shaft speed and the choke clearance are adjusted to give cakes of about ½" thick containing oil ranging from 16 to 20%. The prepress oil flow into the screening tank, while the cakes are conveyed to the cake coolers then to the Cake Bin.

Cleaning of the Prepress Oil

At the Screening Tank, the foots settle to the bottom from where they are picked up by continuously running chain with

paddles, carry them across the drain board, and discharges into the return conveyor. The oil is decanted and pumped to a Surge Tank from where it is pumped through the Filter Press.

The filtered oil flow into a filtered oil Surge Tank and is finally pumped to the storage tank through an Oil Meter.

Solvent Extraction

A screw conveyor picks the cake from the Cake Bin and feeds it to a Granulator. The granulator breaks the cake into particles of about $\frac{1}{4}$" size with minimum amount of fines. The granules are then conveyed by a drag conveyor to the Extractor.

At the Extractor the cake undergoes counter-current washing of fresh solvent and miscella in six stages producing a final miscella with oil content ranging from 25 to 30% and extracted meal containing about 1 to 2% oil on a solvent-free basis.

The miscella is filtered and pumped to the miscella tank. Filter cakes are washed with solvent and conveyed back to the Deselventizer.

Solvent Recovery

Solvent from both the miscella and the extracted meal have to be recovered for economic operations. The solvent in the meal is recovered by a Desolventizer-Toaster while the solvent in the miscella is recovered by the Miscella Evaporator and the oil Stripper.

The vapors from the evaporator are condensed and returned to the extractor while the vapors from the stripper are condensed into a Water Separater where water is separated from the hexane by gravity. The hexane is decanted and returned to the extracter while the water is descharged to the drain.

Escaping vapors from the Extracter and condensers are vented into the Vent Condenser where the vapors are scrubbed with mineral oil. The solvent in the mineral oil is evaporated and recovered into the extracter.

Processing of Meal

The desolventized meal is passed through a meal cooler and conveyed to a meal bin. To increase the moisture content of the meal prior to pelletizing it goes through a ribbon-screw conveyor with fine water spray over it. The moisture content is increased to about 12% - 10%.

At the Pelletizing Mill it undergoes conditioning then pelletized into 3/8-inch pellets. A magnet is provided to remove metals from the meal before it goes through the mill.

The pellets are cooled and conveyed pneumatically to the pellet Bodega. Some pellets are bagged in woven sacks for local sale.

Storage of Oil

The oil from prepressing and from the oil stripper are pumped to the coconut oil storage tank through an oil meter.

Storage of Solvent

Hexane is stored in steel tanks provided cooling water spray on the outside surface of the tank. Hexane has a boiling point of about 65 - 70°C and should be kept cool to prevent solvent losses by vaporization. In other plants cooling is achieved by digging the tank underground. Decision to dig in or to install the tank above ground depends upon the ground-water level at the site.

5.3 Technical Data

Raw Materials Specification (Copra)

Moisture content of copra received	8 - 16%
Moisture content of copra milled	7 - 8%
Oil content of copra received	58 - 65%
Oil content of copra milled	60 - 65%

Product Yields (based on copra milled)

Coconut Oil	63 - 65%
Meal Pellets	30 - 33%

Power consumption	110 - 130 kwh per metric ton copra
Steam consumption	900 - 950 pounds steam per ton copra
Water consumption	10 - 12 cu.m. per ton of copra
Solvent loss	1 - 2% of prepressed meal

6. Quality of Finished Products

Oil	: Color	6 - 8R	36 - 48Y
	FFA	2 - 5%	
	Moisture	not more than 0.2%	
Pellets:	Oil content	1 - 2%	
	Moisture content	10 - 12%	
	Size 3/8 inch diameter.		

7. Machinery Supplier :

French Oil Machinery Company
Piqua, Ohio, U.S.A.

For other machinery suppliers, please see partial list of names and addresses in technology sheet II/1 "INTRODUCTION TO MECHANICAL AND SOLVENT EXTRACTION OF COCONUT OIL .

Product code COCN 15.07 i
Technology sheet no. II / 8

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : FULL-SOLVENT EXTRACTION PLANT PROPOSED BY C.M.B. - 150 T COPRA/DAY

2. Used of finished product : Oil- Raw material in the manufacture of cooking oils, shortening, margarines, soap, glycerine, detergents, plasticizers, surfactants, fatty acids, fatty alcohols.

Copra Meal- Ingredient in the blending of animal feeds.

3. Country of Origin : Project proposed in the Philippines by CMB

4. Equipment:

4.1. Description of Equipment:

Copra Preparation Equipment

1- Copra Bin- 150, metric tons in three compartments of 50 tons, with bottom gates and bottom screw conveyor, made of mild steel materials.

1- Bucket elevator- for transfering of copra from the bin delivery conveyor to the copra crushers.

1- Screw conveyor- to distribute copra to the two crushers.

2- Magnetic separator of the plate type.

2- First-Pass Copra Crusher- for preliminary reduction of copra, with charging hopper, crushing controller, and electric motor drive, steel construction.

2- Second-Pass Copra Crushers- for further reduction of the copra, with charging hopper, hammers, and electric motor drive, made of steel.

1- Cooker-Conditioners- of the superimposed pan type, with steam-heated pans made of steel, vertical shaft scraping paddles made of steel, system to adjust the depth of material in the pans, and enclosed electric motor drive.

1- Magnetic separator- of the rotary-drum type to remove tramp iron from copra, with collecting device and motor.

2- Grinding-Flaking Mill- for the preliminary reduction and flaking of cooked copra. The upper rolls are made of centrifuged cast-iron and are fluted, the lower rolls are smooth. The equipment is equiped with feed distributor, spring-loaded safety device, and an enclosed electric motor drive.

1- Screw conveyor- for collecting copra leaving the crushers.

1- Bucket elevator- for conveying the cooked copra to the magnetic separator and then onto the screw conveyor distributing the copra to the grinding-flaking mills.

1- Screw conveyor- to distribute the cooked copra to the grinding-flaking mills.

1- Chain conveyor- to collect the flaked copra and transfering to the solvent extraction plant.

First-Stage Solvent Extraction

1- CMB Percolation Extractor Model 40- where the flaked copra is partially defatted by means of countercurrent miscella and hexane washes. Equiped with automatic rotary dosing unit and charge hopper, outfeed screw conveyor, and TE FC ex-proof electric motor drive.

The shell is of carbon steel. The casing, framework, and baskets are made of carbon-steel, the drainage screen made of stainless steel, the wheels are of die-cast Silumin, the drag chains are made of high resistance carbon steel.

1- Miscella Recirculating Pump- for pumping solvent countercurrent to the direction of travel of the baskets. The pump is of centrifugal type with TEFC ex-proof motor.

1- Miscella Pump- for pumping miscella leaving the Extractor to the Miscella Filters. The pump is of centrifugal type, with TEFC ex-proof motor, and made of cast iron casing and impeller, and stainless steel shaft.

1- Miscella Heater- for heating the miscella to the desired temperature before entering the Extractor. The tubes are made of carbon steel.

Intermediate Flaking

1- Solvent-Tight Conveyor- for fedding the partially defatted copra from the first Extractor to the hermetic flaker. The conveyor is of endless screw type with carbo-steel casing, flights of stainless steel, and with TEFC ex-proof motor.

2- Hermetically-Sealed Flaker- to rupture the unbroken oil cells and to convert the copra into thin flakes. The flaker is equiped with carbon-steel charge hopper, feed-gate and feeder, TEFC ex-proof motor to drive the feeder; heavy-duty flaking rolls, made of chilled cast iron alloyed chromium-nickel, brushes for cleaning the roller surfaces, level device, pulley-flywheel, and TEFC ex-proof electric motor drive.

1- Hermetically-Sealed Conveyor- for transfering the flaked copra from the Flakers to the second-stage Extractor. The conveyor is of endless screw type with carbon-steel casing, stainless steel flights, and equiped with a TEFC ex-proof motor.

1- Hermetically-Sealed Elevator- to transfer the copra to the top of the Immersion Extractor, of twin-chain tilting busket type. The elevator is of one-body type shell of carbon steel. The shafts and wheels are made of C40 steel, while the chain is of C50 steel. The elevator shell has doors for chain inspection and assembly, and sight glasses. The elevator has a TEFC ex-proof motor with an oil-bath speed reducer.

Second-Stage Solvent Extraction

1- Immersion Extractor- to completely remove oil from the copra coming from the Intermediate Flaker by immersing and mixing in the solvent. The extractor is made of carbon-steel and is of vertical cylindrical design with bell-shaped top, tapered central part, and turncated cone bottom with direct connection to the underlying outfeed conveyor for removing the defatted meal. Conical countersunk screw stirrer rotate inside the extractor to effect complete extraction of the oil in the meal. The end of the stirrer is fitted with two shaped scrapers made of C20 steel to prevent settling of meal to the bottom of the extractor. The miscella outlet pipe is provided with carbon-steel wire mesh and quick-opening cleaning doors. The stirrer is run by a TEFC ex-proof motor and oil- bath speed reducer.

1- Outfeed Screw Conveyor- to remove the defatted meal from the bottom of the Immersion Extractor and convey to the Drainage Conveyor. The conveyor is horizontal and has a 4 cylindrical casing made of carbon steel. The outer part of the screw is brazed with an anti-friction material. The conveyor is driven by a drive assembly consisting of stepless speed change gear, oil-bath speed-reducer and TEFC ex-proof motor.

1- Drainage Elevator-which performs two functions; first, it picks up the deffated meal from the bottom of the Immersion Extractor, and conveys it to the top of the Desolventizer; and secondly,

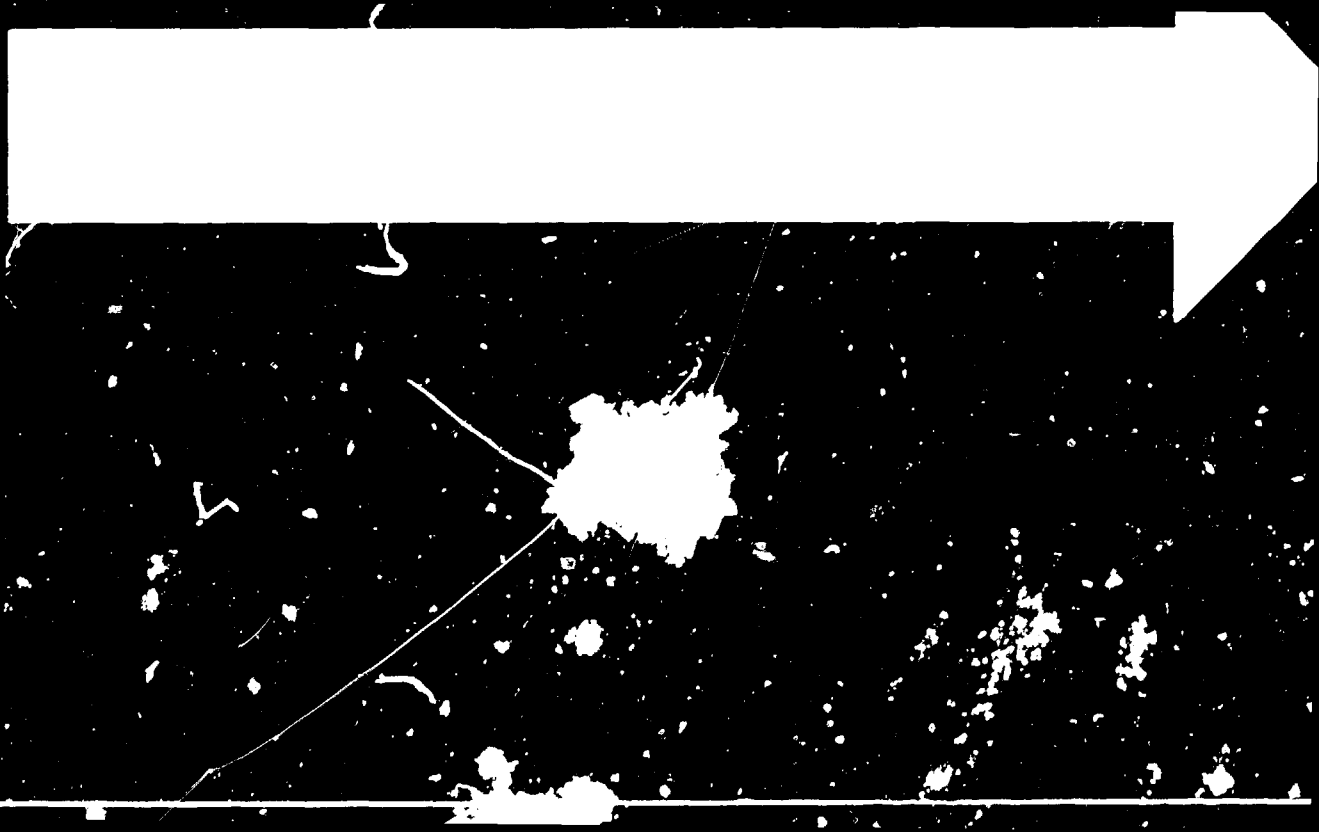
it allows the solvent to drain through the materials in the perforated baskets so as to reduce the solvent content of the defatted meal to the minimum. The elevator is of the twin-chain type with one-body shell made of carbon steel; it consists of vertical component elements with sueprimposed inclined drainage and discharge chute. The shafts supporting the driving and idle sprockets wheels as well as the wheels are made from C40 steel, while the supporting and drawing twin-chain is fabricated in C50 steel. The elevator is driven by a TEFC ex-proof motor.

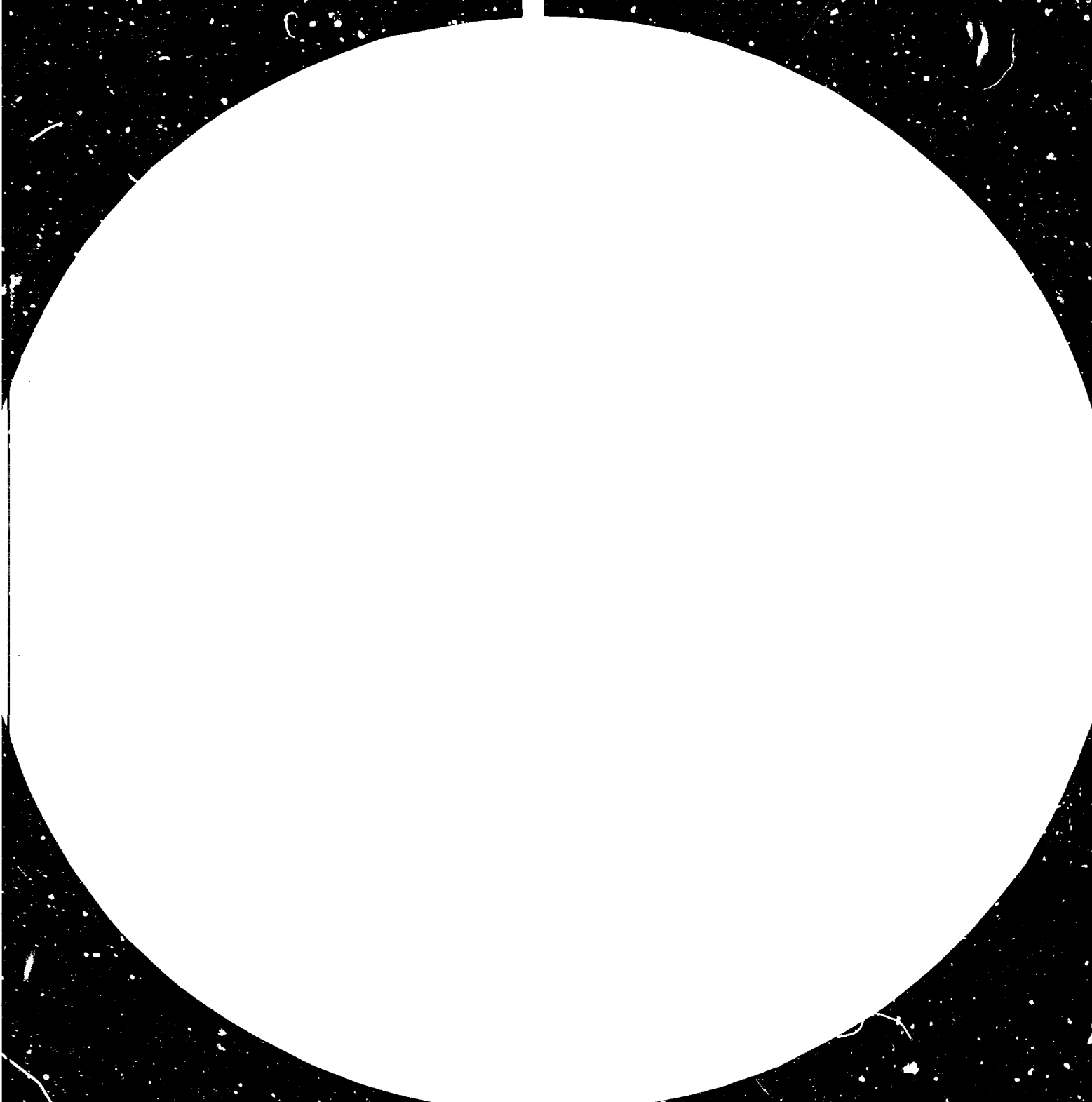
1- Rotary valve- to seal the elevator of vapors distilling from the Desolventizer-Toaster. The valve is of the hermetic type with carbon steel casing and stainless-steel rotor. It is driven and synchronized with Drainage elevator.

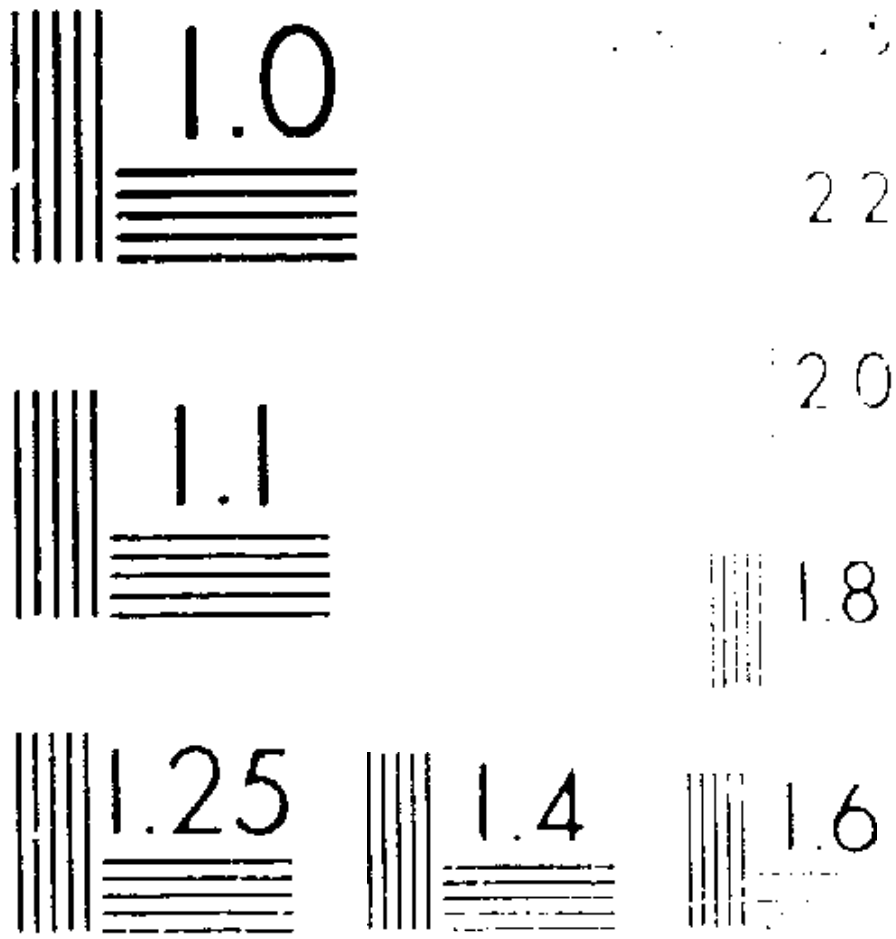
1- Basket Filter- to remove suspended coarse material which may be entrained with the miscella leaving the Immerson Extractor. The filter is of the bag type and is of vertical cylindrical design made of carbon steel, and equiped with quick-opening cover.

1- Desolventizer-Toaster- to remove the solvent from the deffated meal and recovering for reuse. The equipment is of vertical cylindrical design and consists mainly of: the shell made of carbon steel plates, provided with steam jackets; distilling trays with steam-jackets, made of carbon steel; vertical shaft made of high-resistance steel and keyed to it are scraper paddles made of C40 steel which move the meal to be desolventized from one tray down to the next; automatic meal level controller to maintain the depth of the meal on the trays; and a TEFC ex-proof motor drive.

1- Outfed Screw Conveyor- to remove the defatted meal from the Desolventizer; of cylindrical design, made of stainless steel, and equiped with a TEFC ex-proof motor drive.



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2.2
2.0
1.1
1.8
1.25
1.4
1.6

1- Vapour Scrubber- to wash the hexane vapors leaving the Desolventizer by spraying hot water thus removing the entrained fines to avoid clogging of the steam econorizer and condenser. The equipment is of vertical cylindrical design in carbon steel, with lower conical botton and removable dished cover. Inside the machine are baffles to effect circulation of the vapors.

1- Gasifier- to keep the temperature of the scrubbing water at a temperature of 70-80°C.

1- Gasifier Pump- to pump water from the Gasifier and then sprays the water into the Vapour Scrubber.

1- Boiler- to recover hexane entrined in the water leaving the Water-Solvent Separator and the Gasifier by injecting stripping steam.

1- Condenser- to condense hexane vapors from the Boiler; of tube bundle type, water-cooled, vertical cylinder design in carbon steel shell and tube plates, and admiralty metal tubes.

Miscella Pre-Concentration

1- Steam Economizer- to preheat the miscella prior to evaporation by heat exchange with the vapors from the DT. The miscella side is under partial vacuum, thus some of the hexane distills off from the miscella and increase its oil concentration. The equipment is equiped with: feed breach to distribute the miscella uniformly in the tube bundle and is of carbon steel; vertical tube bundle consisting carbon steel plates, shell and tubes; vaporizing chamber of vertical cylinder design and made of carbon steel.

1- Condenser- for condensing and cooling the hexane distilling from the Desolventizer; of the water-cooled tube bundle type, of vertical cylindrical design with carbon steel tuble plates, stainless steel sheel, admiralty metal tubes; equiped with quick-opening cleaning doors and control sight glass.

1- Dephlegmator- to separate, by water spraying, the hexane vapors coming out of the airvent of the Condenser; of vertical cylindrical design with dished-bottom made of carbon steel. It is equiped with quick-opening door, water sprayers, sight glass; and packed with Rashing rings.

1- Condenser- for condensing hexane distilling from the Steam Economizer; of water-cooled baffled tube type, vertical cylindrical design with carbon steel sheil and tube plates, and admitalty metal, tubes.

1- Vacuum Pump- to create and maintain vacuum in the vaporisation chamber of the Steam Economizer, facilitating the distillation of hexane. The pump is of the liquid-seal type with cast iron casing and impellers, and is equiped with TEFC ex-proof motor drive.

1- Preconcentrated Miscella Pump- for transfering the miscelle from the Steam Economizer to the Distiller; it is of rotary self-priming type with cast iron casing, acid-proof alloy impellers, stainless steel shaft fitted with double mechanical seal. It is equiped with TEFC ex-proof motor drive.

1- Hexane Collecting Tank- for receiving the hexane leaving the Condenser; fabricated in carbon steel, of vertical cylindrical design with dished top and flat bottom; with manhole and level indicator.

1- Hexane Removal Pump- to pump hexane from the Collecting Tank to the Hexane Storage Tank; it is of the rotary self-priming type, with cast iron casing, stainless steel impellers and shaft fitted with double mechanical seal; and is equiped with a TEFC ex-proof motor drive.

Miscella Filtering

2- Self-Discharging Rotary Filter- to remove fine particles from the miscella coming from the first Extractor; and consist of: carbon steel housing and filter plate assembly, of vertical cylindrical design provided at the bottom with a special screw stirrer; set of filter plates with heavy wire mesh mounted to a hollow shaft; felt disk which provide sealing of the plates; set of silumin spacers for the filter plates; control and level sight glasses; inspection door; spray nozzles; and equiped with TEFC ex-proof motor.

2- Filter Pumps- to pump the miscella leaving the Filters. It is of the rotary self-priming type with cast iron casing, stainless steel impellers and shaft, and single mechanical seal. It is equiped with TEFC ex-proof motor drive.

1- Miscella Tank- for collecting miscella from the Rotary Filters; fabricated in carbon steel, of vertical cylindrical design, dished top and flat bottom; and equiped with manhole and level indicator.

1- Miscella Pump- to pump miscella from the miscella tank to the Steam Economizer; of rotary self-priming type with cast iron casing, stainless steel impellers and shaft with single mechanical seal; TEFC ex-proof motor.

1- Sludge Pump- to pump the sludge of filter cake and hexane from the Rotary Filters to the Percolator Extractor. It is of Centrifugal type with open impeller, cast iron casing, cast iron impllers, stainless steel shaft with stuffing box; equiped with TEFC ex-proof motor.

Miscella Distillation and Stripping

1- Continuous Distiller- to evaporate hexane from the miscella, and consists of: a feeding breech for even distribution of miscella to be distilled in the tube bundle, made of carbon steel and dished bottom; tube bundle of vertical design and made of carbon steel, of vertical design with dished top, dome, and lower tapered bottom connected to tube bundle. It is also equiped with sight glasses and foam-beaking cone.

1- Condenser- for distilled hexane vapors, of the watercooled bundle type, of vertical cylindrical design with shell and tube plates in carbon steel and tubes in admiralty metal.

1- Water-Solvent Separator- where water and condensed hexane are separated by settling; of the prismatic caisson type, made of steel plates; equiped with manhole, adjustable height siphon for water draining, stuffing box, and sight glass to check hexane coming out of the top by overflow.

1- Stripping Column- to remove, under vacuum, last traces of hexane from the oil coming from the Distiller, and consists of: an oil preheater of concentric tubes; upper expansion chamber, of vertical cylindrical design with dished top, dome, and tapered lower section, with foam breaking cone and sight glasses; cylindrical central chamber holding a series of cascade connected trays; lower boiling chamber, of vertical cylinder design, with dished bottom and tapered upper section, steam coil, live steam injection nozzles, stainless steel float valve, anf sight glasses.

1- Oil Pump- to pump oil from the Stripping Column to the Oil Storage Tank; of the rotary self-priming type with cast iron casing, stainless steel impeller and shaft, and double mechanical seal.

1- Condenser- to condense hexane distilled from the Distilling Column; of vertical water-cooled tube bundle type with shell and tube plates in carbon steel and tubes in admiralty metal.

1- Vacuum Pump- to suck the noncondensibles from Stripping Column; of the liquid-seal type; cast iron casing and impllers; with TEFC ex-proof motor.

1- Oil Cooler- To cool oil from the Distiller. The Cooler is a heat-exchanger of the vertical type, with stainless steel plates tightened by two aluminum die-cast head-pieces with interposed gaskets.

1- Water Tank- to collect water from the Water-Solvent Separator; of horizontal cylindrical design with dished ends, with supporting saddles, opening cover, and level indicator.

1- Water Pump- to pump water from the Water Tank to the Boiler through the Desifier, and also to provide water seal for the two vacuum pumps. The pump is of centrifugal type, cast iron casing and impeller, stainless steel shaft provided with stuffing box.

Vent Solvent Vapors Recovery System

1- Scrubber- to remove solvent leaving the air vents of the Extractors and other equipment by spraying oil; of vertical cylindrical design with dished ends, made of carbon steel. The Scrubber is equiped with quick-opening door, oil sprayer, sight glasses, stainless steel float door, oil sprayer, sight glasses, stainless steel float valve, and Rashig rings packing.

1- Continuous Stripper- to strip the hexane from the scrubbing oil, first by evaporation through indirect steam heating in the tube bundle and then by stripping with live steam in the inner column. The Stripper consists mainly of: feeding breech for uniform distribution of the miscella (oil-hexane mixture) to be distilled in the tube bundle, made of carbon steel; vertical tube bundle made of cabon steel; vaporization chamber, operating under vacuum, made of carbon steel; and a set of control and safety instruments.

1- Oil Pump- to pump oil from the Stripper to the Scrubber after it is cooler in the Oil Cooler. The pump is of the rotary self-priming type, with cast iron casing, stainless steel impeller and shaft provided with double mechanical seal; with TEFC ex-proof motor drive.

1- Oil Cooler- to cool the oil leaving the Stripper before it is recycled to the Scrubber. It is of vertical type, with stamped stainless steel plates, aluminium die-cast head-pieces with gaskets.

Solvent Storage and Preparation

2- Solvent Storage Tanks- of horizontal cylindrical design with dished ends, made of carbon steel; provided with manhole, water drawing well, and connections for filling the tank, and anti-spark tap.

1- Water Pump- for pumping water settled in the Hexane Tank to the Water-Solvent Separator. The pump is of rotary self-priming type with cast iron casing, stainless steel impellers and shaft with single mechanical seal; TEFC ex-proof motor drive.

1- Hexane Pump- to pump hexane from the Hexane Storage Tank to the Extractors; of the rotary self-priming type, cast iron casing, stainless steel impellers and shaft with single mechanical seal; TEFC ex-proof motor drive.

1- Hexane Heater- to heat hexane to be used for solvent extraction; of the verticle tube bundle type heated by steam; with carbon steel tube plates and shell, carbon steel tubes; equiped with thermostats, safety and control devices.

1- Hexane Pump- for pumping hexane to the Filters; of rotary self-primary type, cast iron casing, acid proof alloy impellers, stainless steel shaft with mechanical seal; TEFC ex-proof motor drive.

1- Hexane Heater- for heating hexane going to the filters; made of carbon steel of concentric tube design.

Pelletizing Plant

1- Meal Bin- to store extracted mealprior to pelletizing; vertical cylindrical design, 800 cu.ft volume, mild steel construction.

1- Meal Humidifier- to moisten the cake prior to pelletizing; consisting of a ribbon-type conveyor with high pressure spray pipes, electric motor drive, and water pump.

2- California Pellet Mills- to convert the extracted meal into 3/8-inch pellets, each with a capacity of 4 tons per hour; equiped with 100-hp motor drive, 3/4-inch feeder drive.

2- Pellet Coolers- to cool pellets prior to storage, with exhaust fans and 20-hp motor drive.

1- Bagging and Weighing Machine- to bag and weigh pellets in 100-lb. woven bags at the rate of 80 bags per hour.

Crude Oil Storage

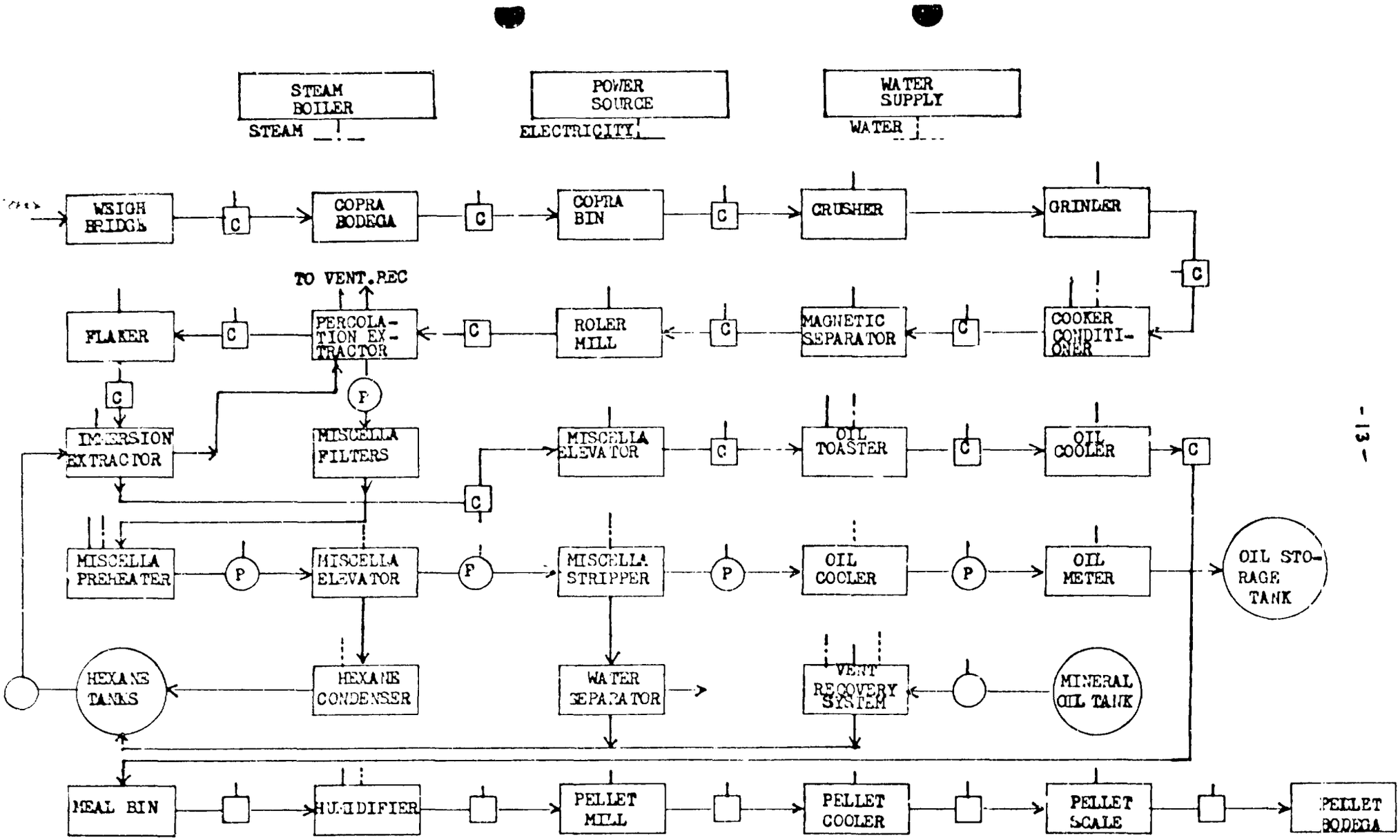
2- Crude oil Storage Tanks- 33 ft diameter by 24 feet high, mild steel construction; conical cover; with manholes, safety ladder and depth gauge, capacity 500 metric tons each.

1- Crude oil Pump- 250 gpm, rotary type, with 15-hp motor drive; to pump oil out of the storage tank; cast iron casing, alloy steel rotors, and steel shaft.

4.2. Materials of Construction- Refer to Equipment Description

4.3. Estimated cost of Equipment:

CPB Portion	-	US$ 1,570,000
Pelletizing Plant-		US$ 117,000
Crude Oil Storage-		US$ 125,000



SIMPLIFIED FLOW DIAGRAM

CMB DIRECT OIL-EXTRACTION PLANT

4.4 Capacity- 150 metric tons of Copra per 24 hours of operation

5. Process

5.1. Process Flow Diagram- See attached flow diagram sheet

5.2. Description of Process

Delivery and Storage of Copra

Copra is delivered to the Bodega in jute sacks by trucks. The weight of the copra is determined by weight-in minus weight-out through the weighbridge. The final price of a copra delivery is based on classification and laboratory analysis.

Copra is transfered to the Bodega by opening the sacks, emptying the copra into a receiving conveyor, lifting by bucket elevator into an overhead conveyor inside the Bodega, and finally dropping the copra through distribution chutes. Storage time is from 15 to 30 days to allow for drying and moisture equalization. Storage is arranged in lots and the copra is withdrawn on a first-in first-out schedule.

Copra Transfer and Preparation

The copra is transfered to the Mill by a network of floor conveyors; a rotor-lift which lifts the copra from the collecting floor conveyor to an overhead transfer conveyor to the Mill. At the Mill the copra is received in a Day-Bin.

From the Day Bin, a screw conveyor brings the copra to a bucket elevator which lifts and drops the copra to the first-pass Copra Crusher. A Magnet located over the inclined through bridging the top of the Elevator and the Crusher picks tramp iron in the copra.

The First Crushers breaks the copra to chunks of $\frac{1}{2}$" to $\frac{1}{4}$" size. The Second-Pass Crushers further reduce the size to 1/16" to 1/8".

The crushed copra is then passed, through the Cooker-Conditioner to dry the copra and bring the moisture to the rolling temperature. The copra is finally rolled into thin flakes and conveyed to the first Solvent Extractor. A magnetic separator picks all iron before the copra is fed to the roller.

Solvent Extraction

The copra is fed to the Percolation Extractor through a charging hopper fitted on top of the equipment. Through this hopper the copra is dumped automatically into the basket which is washed by the rich miscella. In the Extractor, the copra undergoes counterflow washing with solvent and miscella, in a manner that, as the oil content of the copra goes down it is washed with leaner miscella so that at the end, the outgoing meal is washed with the lean miscella from the immersion Extractor. The oil content of the final rich-miscella is about 30% while oil in the meal is about 12%, on a solvent-free basis.

The partially defatted meal is taken out of the extractor by a screw conveyor and transfered to a Solvent-Tight Flaker, where still intact oil cells are briken up. The flaked meal is then conveyed by the Bucket Elevator to the top of the Second-Stage (Immersion) Extractor.

In the Immersion Extractor, the meal is washed in a solvent bath which moves in a path countercurrent to the decending meal. During this stage, the residual oil contained in the meal is reduced to about 1% (solvent-free basis). The lean miscella leaving the top of the Extractor passes through a Basket Filter, then pumped to the Percolation Extractor.

The deffated meal is picked up by the Drainage Elevator. As the meal is lifted in the Elevator, it is further washed by a counter-current flow of fresh solvent which further reduces the oil content. In the elevator the solvent is draned out of the meal thus reducing the load of the Desolventizer. The drained meal is then fed to the top of the Desolventizer- Toaster.

Processing of the Miscella

The rich Miscella from the Percolation Extractor is pumped through the Rotary Filters which remove solid impurities from the miscella thus preventing fouling of the subsequent miscella evaporating equipment. The filtered miscella is pumped first to the Steam Economizer where it is preconcentrated by heat exchange with the hot vapors leaving the Desolventizer-Toaster, then to the Miscella Distillation Equipment where hexane is evaporated, condensed, and recovered. From the Distillation Column, the oil is pumped to the Stripping Equipment where the last traces of solvent in the oil are removed by stripping with steam under vacuum. The solvent-water vapors are condensed and delivered to the Water-Solvent Separator where the solvent is recovered for re-use.

The solvent-free oil from the Stripper is passed through an Oil Cooler and is finally pumped to the Storage Tank. The oil production is measured by an Oil Meter connected in-line with the oil pipe to the storage tank.

The filter cake is washed with solvent to form a slurry which is pumped back to the Percolator. The two Filters are operated alternately- one on duty while the other is being washed or cleaned.

Processing of the Defatted Meal

Solvent in the deffated meal is removed in the Desolventizer-Toaster by heating the meal on steam-heated trays while being mixed by the scraper blades, and stripping with steam in the toasting section of the equipment.

The vapors leaving the top of the D-T pass through a Scrubber where entrained fines are scrubbed by hot water spray, then to a Steam Economizer where the vapors are precooled by heat exchange with the miscella, and finally to a Condenser where the solvent is recovered to be pumped back to the Solvent Tank.

The deffated, desolventized meal is cooled and conveyed to the Meal Bin. A conveyor draws the meal from the Bin to the Humidifying Equipment where water is sprayed onto the meal, and finally goes to the Pelletizing Mill which converts the meal to pellets. The pellets are conveyed to the Pellet Bodega for shipment or bagging.

Recovery of Vent Vapors

Solvent vapors escaping from the Extractors and Condensers are recovered by a vent vapors recovery system. The system consists of a Scrubber where the solvent is disolved by mineral oil; a Stripper which recovers the solvent from the oil; and an Oil Cooler which re-cools the oil for re-circulation.

5.3. Technical Data

Raw Materials Specification (copra)

Moisture content of copra milled- 7 - 8%

Oil Content of Copra Milled- 60 - 65%

Product yields (based on copra milled)

Coconut Oil 63 - 65%

Meal Pellets 30 - 33%

Power Consumption 45 - 50 kwh per ton of copra

Steam Consumption 1,200 - 1,500 pounds per ton copra

Water Consumption 18 - 24 cu. m. per ton of copra

Solvent loss 1 - 2% based on copra processed

6. Quality of Finished Products:-

Oil: Color 6-8R 36-48Y

FFA 2-5%

Moisture content not more than 0.2%

Pellets: Oil Content 1-2%

Moisture content 10-12%

Size 3/8" diameter

7. Machinry Supplier : Solvent Extraction Plant- CMB
(Costruzioni Mechaniche Bernardini)

For the machinery suppliers see technology sheet no. II/1 "INTRODUCTION TO MECHANICAL AND EXTRACTION OF COCONUT OIL" for partial list of names and addresses.

Product code CCCN 15.07 1
Technology sheet no. II / 9

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : OIL AND FLOUR THROUGH EDIBLE COPRA PROPOSED BY ANDERSON - 150 T COPRA/DAY

2. Used of finished product : Oil- Raw material for the production of Cooking Oil, Margarines, and Shortening.

Edible Coco-Flour- Used as a high-protein food. Mixed with wheat flour in making bread and other bakery products. Can also be used as a meat extender.

3. Country of Origin : Philippines

4. Equipment:

4.1. Description of Equipment:

Nuts and Copra Receiving and Storage

1- Weighbridge, 30 T capacity, 50' x 10' platform, ticket printer for weighing copra, and nuts.

1- Set of receiving conveyor, rotor-lift, and distribution conveyor for transfering copra from bags to the copra silos.

5- Copra Silos, 150 metric tons capacity each, with air ventillators, sanitary cover with filtered air vent, discharge conveyors; made of heavy GI sheets and mild steel supports.

6- Nut Bins, each with a capacity of 100 metric tons of unhusked nuts, with corrugated asbestos roofing, concrete walls and floors, and wooden gates.

In-Plant Copra Making

100- Deshelling Boxes; with nut boxes, shelling pads, conveyors for in-coming nuts and out-going kernel and shells; made of wood, conveyors made of mild steel and oil-resistant conveyor belts.

1- Washing Conveyor for washing kernels, 2' diameter through by 16 feet long; with hot water spray system, and drainage box; flight and trough made of stainless steel; with 2-hp motor.

1- Kernel Cutter to cut washed kernel into 1-inch pieces; vertical screw type, 24" diameter by 30" high; made of stainless steel; with 2-hp motor.

1- Kernel Conveyor for transfering copra from Cutter to the Kernel Bin; screw-type; 18-inch diameter trough by 20' long; made of stainless steel and equiped with 3-hp motor.

1- Copra Dryer for drying kernel; tunnel and try type, forced draft; with heat-transfer ducts for Boiler flue gas; walls made of GI sheets, steel structure, steel ducts; stainless steel trays; equiped with 12 2-hp fans; capacity 25 tons of copra per day.

1- Copra Dryer for drying kernels; tunnel and tray type, forced draft; with heat-transfer pipes for exhaust steam from turbines; walls made of GI sheets, steel supports and pipes, stainless steel trays; with 12-2-hp fans.

1- Copra Cutter for cutting copra to ½" size before tranfering to copra bin; capacity 8 tons per hour; with 25-hp drive.

3- Copra bins, each with a capacity of 50 tons of copra; vertical cylindrical design, with sanitary conical cover; made of heavy GI sheet on steel supports.

1- Set of conveyors for transfering copra from dryers and copra cutter and distributing the copra to the copra bins; made of stainless steel, with GI sanitary covers, and motor drives.

Copra Preparation and Pre-Pressing

1- Conveyor from copra bins to Copra Pre-Crusher; screw type of stainless steel trough and flight, with GI sanitary cover; 2-hp electric motor drive.

1- Magnetic Separator with spreader; drum type electro-magnet; in line with the copra conveyor to Pre-Crusher.

1- Copra Pre-Crusher; consisting of a crusher with coarse granulating bars, in carbon steel construction; with magnetic separator, and 7½-hp motor.

1- Copra Disintegrator; of cast iron construction with hardfaced hammers; ½" diameter perforated screens and 75-hp motor drive.

1- Set of conveyors to transfer copra from Crusher to Desintegrator; consisting of a horizontal screw and a rotor-lift; all equiped with dust-free sanitary covers; of stainless steel construction; with independent motor drives.

1- Set of conveyors for transfering copra from Desintegrator to Cooker-Conditioner consisting of a horizontal screw and a rotor-lift; of stainless steel trough, flights, and shell and GI sanitary covers; with independent motor drives.

2- Special French Dual Cage Screw Press with water-cooled cage and barrel; equiped with water-cooled two-speed shaft with separate all-coated reversible dischrage worms and tapered collars, adjustable cone mechanism. The Pres is driven by a 200-hp motor with a variable-speed mechanism.

1- Set of conveyors to transfer copra from Cooker-Conditioner consisting of a horizontal screw; a rotor-lift, and a distribution

conveyor; all of stainless steel with GI sanitary covers; equiped with independent but synchronized motor drives.

1- Overflow bin and copra return conveyor to return overflow from expellers to feed conveyor; of stainless steel construction with sanitary covers.

1- 7-high, 100" diameter Cooker-Conditioner with all bottoms steam-jacketed; with automatic floating type gates to control level of material; scraper paddles, automatic temperature control for each chamber; and 60-hp motor drive; all parts in contact with material of stainless steel.

1- Rotary-type Cake Cooler; with filtered cooling air system; parts in contact with material of stainless steel; with two motor drives.

1- Set of conveyors to transfer copra cake from Screw Press to cake cooler; of stainless steel construction and with sanitary covers; synchronized motor drives.

1- Set of conveyors from Cake Cooler to Solvent Extractor; drag-chain type; all parts in contact with materials of stainless steel; with variable speed motor drive.

1- Oil Drainage Trough from Screw Press to Screening Tank; made of mild steel; and equiped with a riboon screw to move the foots, with 1-hp motor drive for the screw.

1- Copra Cake Granulator for breaking prepress cake prior to solvent extraction; with 5-hp motor drive.

Solvent Extraction

1- Basket-type Solvent Extractor; consisting of 12 compartment with 6 extraction stages; equiped with 2-hp feed conveyor; miscella and solvent distribution pipes; out-take sealed conveyor; motor drive for baskets and out-take conveyor

5- Miscella pumps, centrifugal type with TEFC ex-proof motor.

1- Solvent pump, centrifugal, with TEFC ex-proof motor.

1- Miscella Evaporator; consisting of a long tube evaporator with 30 1-¼" O.D. stainless steel tubes 15 ft. long with entrainment separator and automatic level controller.

1- Stripping Column; 14-inch diameter x 30' high; with steam injection nozzles, vaccum system; 16" diameter x 6' long condenser.

1- Primary condenser, 30" diameter x 8 ft long; 860 sq. ft. of heat-transfer surface.

1- Secondary condenser, 16" diameter x 6 ft long.

1- Final Solvent Recovery System consisting of a 10" diameter mineral oil scrubber, 10-inch diameter mineral oil stripper, oil heater, oil cooler; with pumps and instruments.

1- Solvent-Water Separator to recover hexane from hexane and water condensate from stripping column.

1- Desolventizer-Toaster and Flash Desolventizer System, equiped with feed conveyor, 72" meal collector, 40-hp centrifugal blower, 1100 sqft hexane superheater, 48" vapor scrubber, sealed discharge conveyor, temperature and pressure monitoring instruments, combination pneumatic meal cooler/conveyor.

3- Pumps for solvent and miscella from vacuum units.

1- Finished oil Pump.

1- Cold water pump.

1- Finished oil pump.

1- Steam condensate tank and pump.

Processing of Extracted Oil

1- Automatic Oil Settling Tank having three separate settling chambers, each with a continuously running chain with paddles

to pick up the foots, carry them across the wedgewire, drain board to remove the free oil, and discharge this foots back into the run-around conveyor system.

2- Plate and Frame Filter Presses, 36 inches square x 42 plates, with hydraulic closing device.

1- Pump to pump oil from Settling tank to Filter presses.

1- Pump to transfer oil from Filter Press to Filtered oil tank.

1- Pump to transfer oil from filtered oil tank to storage tank.

1- Filtered oil tank, 10 tons oil capacity, of mild steel construction, vertical cylinder design.

1- Oil Meter, volumetric type; installed in line with pipe carrying oil to the storage tanks.

Processing of Meal to Edible Flour

1- Meal Bin, 10 cu. m capacity; vertical cylinder design with sanitary cover; recovery cyclone, dust bag, of stainless steel material.

1- Flour Mill Plant consisting of grinders and pulverizers; cyclone classifiers, gyrating screens, recovery cylones, and bag dust filters.

1- Set of conveyors to transfer materials in flour mill.

1- Flour Bin, 15 tons capacity, of stainless steel material; vertical cylinder design with sanitary cover.

1- Bagging and Weighing Equipment, automatic; with hopper, gross scale; capacity 6000 pounds per hour in 100-lb weighouts.

Off-Site Equipment

1- Steam Boiler, water-tube type, with brick furnace for burning coconut shell fuel, capacity 34,500 lb. per hour steam at 250 psig; equiped with multi-cyclone flue dust separator and high temperature flue gas blower for blowing hot flue gas to the copra dryer.

1- Tubo-Generator, 500 KVA Generating Unit at 440 volts, 60 cycles, 3-phase; non-condensing type turbine using 250 lb. superheated steam with a back pressure of 10 psig. Exhaust steam to be used in copra dryer.

2- Crude oil Storage Tanks, each with a capacity of 500 metric tons of oil, 33' diameter by 24 ft. high; mild steel material.

1- Crude oil loading Pump, rotary type, capacity 500 gpm, with 30-hp motor drive.

1- Cooling tower, natural draft, 300 gpm with a cooling range from 120°F to 80°F; with recirculation pump, catch basin.

1- Water Supply system, deep well and storage tank; 150 gpm.

1- Boiler Feed water Treatment System.

4.2. Materials of Construction- Refer to equipment description

4.3. Estimated cost of Equipment- US$ 2.7 Million including off-site, and copra drying equipment.

4.4. Capacity- 150 metric tons of copra per 24 hours operation.

5. Process

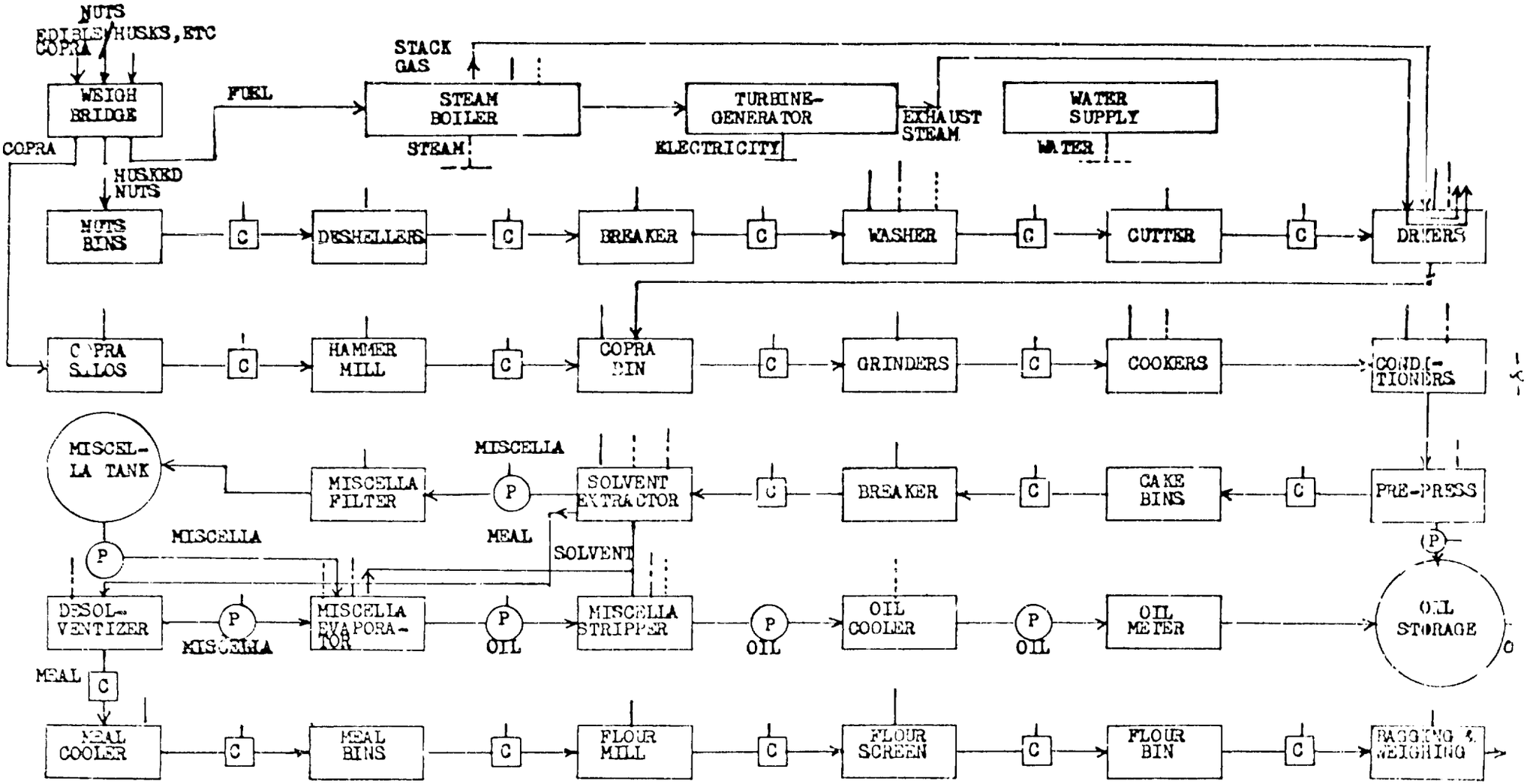
5.1. Process Flow Diagram- Refer to attached flow diagram sheet

5.2. Description of Process:

Delivery and Storage of Copra

Copra used is of edible-grade, produced in Copra Centrals specifically designed and operated to produce edible copra. The copra is packed in clean polyethylene bags and transported to the Mill in clean covered vans.

In the Mill the copra in bags are stacked in the Copra Bodega or debagged and stored in specially-designed silos equiped with ventillators. All conveyors and handling equipment are covered to prevent contamination of the copra.



SIMPLIFIED PROCESS FLOW DIAGRAM
PROPOSED HIGH-GRADE OIL AND COCO-FLOUR EXTRACTION PLANT
USING COCO - SHELLS AND HUSKS FOR STEAM AND POWER GENERATION

In-Plant Copra Production

About 50% of the copra requirement are produced in-plant to make available coconut shells for fueling the steam boiler and copra dryers.

Unhusked nuts are delivered to the plant, weighed on the weigh bridge and stored in the nut bins. Spoiled nuts are hand-picked to be made into ordinary copra.

The nuts are conveyed to the deshelling station where the shells are removed manually using deshelling tools. The shells are carted to the Boiler house for fuel. The kernels are conveyed by a belt conveyor to the washing conveyor. In the washer, the kernels are sprayed on with high pressure hot water while they are stirred and conveyed continuously.

The washed kernel are then cut into small pieces of about 1-inch size and conveyed to the dryers.

Three dryers are used; one heated by boiler flue gases; one heated by exhaust steam from the steam turbine; and the third is independently heated by flue gases from a shell-fired furnace. The dryers are of the tunnel type with rolling trays travelling in a train through the length of the dryer, semi-continuously. Hot air is circulated, by means of motor driven fans, in several passes to maximize heat utilization. The copra are allowed to cool in a cooling room before they are conveyed to the copra bins.

Copra Preparation and Oil Extraction

Copra from Copra Centrals are of large sizes. They are first crushed to about $\frac{1}{2}$" size and conveyed to the copra bin to be mixed with in-plant copra.

From this point the copra is propessed by conventional pre-pressing and solvent extraction. However all conveyors and handling equipment are made of stainless steel and provided with sanitary covers.

Flour Milling

The solvent extracted meal from the meal bin is conveyed to a first stage pulverizer. The pulverized meal is conveyed pneumatically to a classifying cyclone. The fines are fed to a Screener with 80-mesh screens, the fines are conveyed to the flour bin; while the coarse particles are conveyed to a second pulverizer where it undergoes second grinding together with the coarse product from the classifying cyclone. The material coming from the second pulverizer is conveyed to the Screener.

The coconut flour is packed in standard 100-lb flour bags. The bags are transported to the Flour Bodega in pallets by forklift trucks.

Storage of Products

The coconut oil is stored in two 500-metric ton steel storage tanks. The flour bags are stacked in sanitary and ventillated bodega.

Steam and Power Generation

The steam requirements of the plant is generated by a shell-fired Steam Boiler. Defficiency in fuel will be supplemented by shells and husks purchased from external sources. The hot flue gases are used for copra drying.

About 50% of the power supply will be generated by a steam-tubine- driven Generator driven by steam from the Steam Boiler. The exhaust steam is used for copra drying.

5.3. Technical Data:

Raw Material Specifications

Edible Copra: Oil content- 65-70%
Moisture content- 6-7%
Mold and bacteria-free
Clean and white

Coconuts; Mature nuts 12 to 15 months old
without cracks and free from spoilage
To be delivered clean of husks.

Product Yields

Cocomut oil 64-68% (average 65%)
Coconut Flour 30-34% (average 33%)

Power consumption 70-80 kwh per ton of copra (external source)

Steam consumption 900-1000 lb per ton copra (self-sufficient)

Water consumption 10-15 cu. m per ton of copra

Solvent loss 1-2% of pre-press cake

6. Quality of Finished Products

Cocomut oil- Color 1-2R 6-12Y
FFA 0.5-1.0% as oleic
Moisture Content not more than 0.2%

Coconut Flour- (average analysis)
Particle size 80-mesh
Moisture content 5.3%
Oil content 2.0%
Protein content- 24.8%
Carbohydrates- 52.6%
Ash- 5.5%
Crude Fiber 9.8%

7. Source of Information: P. C. Catanaoan
President,
Sta Cruz, Agro-Industrial Corporation

Note: This Project has been approved for implementation by the Board of Investments of the Government of the Philippines.

P.C.C. 1979

Product code CCCN 15.07 1
Technology sheet no. II / 10

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : OIL FROM FRESH NUTS - PROPOSED PLANT BY ANDERSON - 250 T HUSKED NUTS/DAY

2. Uses of finished products: Oil - used as raw material for the manufacture of edible oil, margarines, shortening.

3. Country of origin : Dehydration process developed in the U.S.A. Kernel preparation system developed in the Philippines.

4. Equipment :

4.1 Description of Equipment

Nut Receiving

1- Weighbridge - 30 T capacity, 50' x 10' platform, with ticket printer, two-section straight lever scale.

6- Nut Bins - for storage of husked nuts, each with a capacity of about 250,000 nuts; concrete floor and side walls, wooden gates, and corrugated asbestos roofing.

1- Payloader - diesel fuel driven, 0.5 cu.m. bucket, rubber wheels.

Kernel Preparation

100- units, Deshelling Stations, with nut boxes for 500 nuts, deshelling pads, shell boxes; structures of wood material, synthetic rubber conveyor belts.

300- Deshelling Tools - for manual removal of shells from nuts, made of tool steel.

3- Nut Distribution Conveyor - to convey and distribute nuts to the nut boxes, consisting of an inclined drag-chain conveyor to lift nuts to the belt distribution conveyor; each driven by 5-hp motor.

2- Kernel Conveyors - to collect kernels from deshelling stations to the kernel collection conveyor belt conveyors; each with 3-hp motors with speed reducers.

1- Kernel Collecting Conveyor - to collect kernels from the kernel conveyors and deliver them to the washing conveyor; 300 mm diameter by 10 meters long; made of stainless steel; with 5-hp gearmotor.

1- Rinsing Conveyor - Inclined screw conveyor for washing kernel prior to processing; 500 mm diameter by 8 meters long; with high pressure water spray nozzels; stainless steel material; equipped with 5-hp gearmotor.

1- Inclined Transfer Conveyor - screw conveyor to transfer washed Kernels to Kernel Surge Bin; 500 mm diameter by 10 meters long, stainless steel material; equipped with 5-hp gearmotor.

Kernel Dehydration

1- Kernel Surge Bin - 7 cbm capacity, mounted over twin 500 mm screw conveyors driven by 10-hp gear motor; stainless steel construction.

1- Prebreaker - heavy duty, industrial type unit for preparing kernel preparatory to feeding to process; with hopper, cast-bolted anvils; hammers keyed to shaft; stainless steel construction; equipped with 100-hp motor with speed reducer.

1- Inclined Screw Conveyor - to transfer kernel from the Prebreaker to the Feed Control Bin; 400 mm diameter, made of stainless steel; equipped with 5-hp gearmotor.

1- Feed Control Bin - to control flow of kernel to process; with high and low level controls, live-bottom variable-speed triple screw discharge conveyor, 7.5-hp motor and drive; stainless steel material.

1- Fluidizing Tank - for suspending crushed kernel in oil; vertical cylinder design; stainless steel material; with 7.5 hp agitator.

1- Fluidizing Tank Pump - to deliver slurry of oil and crusned kernel from Fluidizing Tank to Desintegrator; cast iron material; with 10-hp motor.

1- Desintegrator - for final wet grinding of kernel slurry from Fluidizing Tank; heavy-duty; with 75-hp motor.

1- Evaporator Feed Pump -(first stage) - to deliver a uniform flow of slurry to the first stage evaporator from the level control tank; open impeller centrifugal pump with 25-hp motor, cast iron construction.

1- Evaporator Feed Pump (2nd stage) - to deliver a uniform flow of slurry from the first stage evaporator to the 2nd stage evaporator; open impeller centrifugal pump with 20-hp motor; cast iron construction.

1- Double-effect Evaporator - to remove water from the kernel slurry; falling-film type; with riser pipe, sight glasses, product mixer pipe; temperature controls; 304 stainless steel construction.

1- Main Condenser - to condense vapors from the Evaporators and to assist in the maintenance of vacuum; 304 stainless steel tubes and cast iron body.

1- Ejector System - to create vacuum in the evaporators; two steam-jet ejector with intercondenser and after condenser; steel body and stainless steel contact parts.

1- Recirculation Pump (first stage) - to recirculate slurry in the first stage Evaporator; centrifugal open impeller type, stainless steel construction; with 75-hp motor.

1- Recirculation Pump (2nd stage) - to recirculate slurry in the 2nd stage evaporator; centrifugal open-impeller type; stainless steel and cast iron material; with 50-hp motor.

1- Centrifugal Feed Pump - to feed water-free slurry to Centrifuge; centrifugal open-impeller type, stainless and cast iron material; with 15-hp motor.

1- Centrifuge - to separate oil from dehydrated kernel; solid-bowl continuous centrifuge; stainless steel and cast iron material; with 40-hp motor.

1- Expeller Press Surge Bin - to store centrifuged kernel to assure continuous feed to Expeller; rectangular design, with double screw bottom conveyors; stainless steel contruction; with 1.5-hp motor drive for each conveyor.

1- Recycle Oil Tank - to hold oil from Centrifuge prior to recycling to Fluidizing tank; cylindrical design, stainless steel material, with bubbler connection for level indication.

1- Oil Pump - to deliver oil from Oil Recycling Tank to Fluidizing Tank; centrifugal open-impeller type; cast iron material; with 10-hp motor.

1- Centrifuged Discharge Conveyor - to transfer solids from centrifuge to Expeller Surge Bin; screw conveyor with 10-hp motor; stainless steel material.

Oil Extraction

1- Anderson (AN-6-E) Heavy Duty Duplex Super Duo Expeller- to extract the oil from the dehydrated kernel. Equipped with 14" conditioner vessel; five section horizontal (55"), and long (25-5/8") vertical drainage barrels; heavy duty water-cooled hard-faced Main Worm shaft driven by a 75-hp motor; assembled vertical shaft driven by a 60-hp motor; thrust unit choke unit; and "across the line" starters.

Oil and Meal Processing

1- Anderson No. 18 (AN-82-E) Oil Screening Tank - to screen out entrained foots from the oil leaving the Expeller; mild steel construction; with 1-hp motor to drive conveyor.

1- Oil Pump - to pump oil from Screening Tank to Unfiltered Oil Tank; centrifugal; cast iron material; with 2-hp motor.

1- Unfiltered Oil Tank - to hold oil from Screening Tank prior to filtering, 2000 gallon capacity, mild steel construction; equipped with a 3-hp agitator.

1- Filtering Pump - to pump unfiltered oil through Filter Press, rotary type; cast iron material; with 5-hp motor.

1- Plate and Frame Filter Press - to clarify oil from Screening Tank; 36 x 36 with 42 chambers for forming 1½ cakes; flush type plates; cast iron material; with ratchet gear closing device, oil receiver, cake catch pan.

1- Filtered Oil Tank - to hold filtered oil prior to pumping to the oil storage tank; 2000 gallon capacity; cylindrical design, mild steel material.

1- Oil Pump - to pump filtered oil from the filtered oil tank to the Oil Storage Tank; centrifugal; cast iron material; with 10-hp motor.

1- Vegetable Oil Meter - to measure coconut oil pump to the oil storage tank; calibrated in liters on straight reading dial; automatic temperature compensating unit.

1- Lot of cake and meal conveyors and elevators; total of 20-hp motors; stainless steel material.

1- Anderson (AN-195-E-ST) Rotary Cake Cooler - to cool the expeller cakes prior to grinding; walls and cover of stainless steel; with 5-hp motor.

1- Cake Grinder - to grind expeller cakes prior to bagging; disk type; with permanent magnet, inlet chute, screens and 30-hp motor.

1- Meal Bin - to hold ground meal prior to bagging; 100 cbm capacity; cylindrical, stainless steel construction.

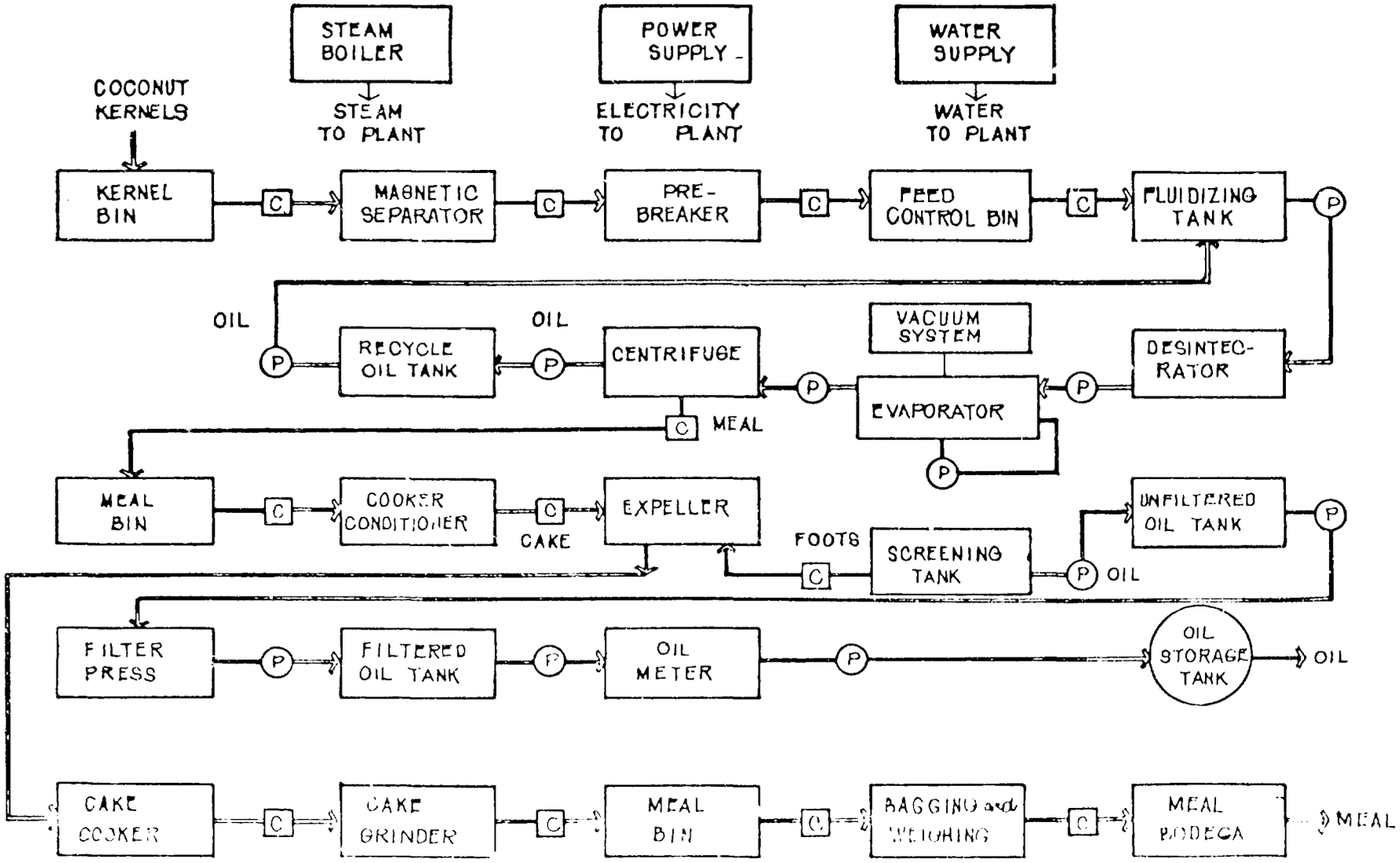
1- Bagging and Weighing Equipment - for bagging pulverized meal. Capacity 1500 kg per hour of 50 kg weighouts, includes bag closing machine.

1- Coconut Oil Storage Tank - capacity 500 metric tons of oil; cylindrical, mild steel, with conical top cover safety ladder, cleaning manholes, and level indicator.

4.2. Materials of Construction - Refer to equipment description.

4.3. Cost of Equipment (estimate) - US $ 2,700,000 F.O.B. (as listed)

4.4. Capacity - 250 metric tons of husked nuts (equivalent to 50 tons of copra) per 24 hours operation.



PROCESS FLOW DIAGRAM
ANDERSON PROCESS FOR COCONUT OIL EXTRACTION
STARTING WITH FRESH NUTS

LEGEND:
[C]- CONVEYOR
(P)- PUMP

5.2. Description of Process:

Nuts Delivery

Husked mature nuts are delivered to the plant in trucks. A weighbridge is used to determine the weights of nuts deliveries. The nuts are stored in any one of the six Nut Bins. While the nuts are being transfered from the trucks to the Bins, immature and spoiled nuts are hand-picked and returned to the supplier. Withdrawals of the nuts for processing are scheduled on a first-in first-out basis. Long exposure of nuts to sunlight during transport and storage should be avoided to Prevent cracking of the nuts. Cracked nuts spoil quickly.

Kernel Preparation

The nuts are transfered from the Nut Bins to the nut conveyor hopper by means of a payloader. A drag-chain inclined conveyor elevates the nuts to the belt conveyor which in turn distributes the nuts to the nut boxes at the deshelling stations.

The nuts are deshelled manually using a deshelling tool (ax). An experienced sheller can deshell at least 1000 nuts per 8 hours work. The kernels are then cut open to drain out the water. Belt conveyors collect the kernels from the stations and deliver them to a collecting conveyor which delivers the kernels to the washing conveyor.

At the washing Conveyor, which is an inclined screw conveyor, the kernels are washed by high pressure water sprays along the whole length to the conveyor. This rinses out dirt and foreign matter from the kernels.

Finally, the washed kernels are conveyed to the Kernel Surge Bin in the dehydration plant.

Dehydration of Coconut Kernels

From the Kernel Surge Bin, the kernels are conveyed past a Magnetic Separator, which draws out tramp iron, to the kernel Prebreaker. The prebreaker cuts the kernels into small particles. An inclined screw conveyor transfers the crushed kernel to the Fluidizing Tank.

At the Fluidizing Tank, recycled oil from the Centrifuge is added to the kernels at a specified uniform rate to form a slurry. A stirrer keeps the kernel in uniform suspension in the oil. The slurry is pumped continuously to the Desintegrator.

The Desintegrator grinds the kernel in oil into an almost homogenous mash slurry consisting of kernel fines, water and oil. This slurry is next fed to the first stage evaporator.

The water from the slurry is evaporated under vacuum in a series of two evaporators. A two-stage steam-jet ejector connected to the second-stage evaporator creates the vacuum. A main condenser, and intercondenser, and after condenser with barometric legs condense the evaporated water and the ejector steam. Recirculating pumps for each of the stages keep the slurry in suspension during the evaporation process. The product leaving the 2nd stage evaporator is a slurry of dried kernel fines in oil which is subsequently pumped to the Centrifuge.

The Centrifuge separates most of the free oil from the kernel. The separated oil is pumped to the Recycle Oil Tank for recycling to the Fluidizing Tank. The dehydrated kernel is conveyed to Expeller Surge Tank in the oil extraction plant.

Oil Extraction (Full-Press)

From the Expeller Surge Bin, the dehydrated kernel is fed to the Conditioner where it is heated to about 115°C and kept at this temperature for about 20 minutes and then fed to the Expeller where it is subjected to double pressing. The main worm of the expeller is water cooled while cage is cooled by cool oil spray to reduce the extraction temperature. The cake leaves the expeller with an oil content of about 7% at a temperature of about 100°C. The extracted oil leaves at the same temperature with about 20% entrained solids. The cakes are conveyed to the Cake Cooler while the oil flow to the Screening Tank.

Processing of Extracted Oil

At the Screening Tank, the foots (solids) settle at the bottom and are continuously scooped out by a series of chain-mounted scrapers which lift the foots to the screen on top of the tank. The oil in the foots is drained out as they travel across the screen. At the end of the screen the foots drop into a screw conveyor which brings them back to the Expeller.

The oil in the Screening Tank is decanted and pumped to the Unfiltered Oil Tank. The oil contains about 10% solids which are kept in suspension by an agitator. To remove all the solids and clarify the oil, it is flitered in a plate and frame Filter Press, and finally pumped to the Oil Storage Tank. A Vegetable Oil Meter in line with the oil product line to the storage tank measures the quantity of oil produced.

Processing the Expeller Cake

The cakes which leave the expeller at about 100°C are cooled down to about 60°C as they pass through the Cake Cooler. The cakes are cooled by cross-flow with cool clean air. The cooled cakes are then pulverized by a disk mill into about 40 mesh meal fines.

The meal powder is conveyed to the meal bin from where it is bagged for storage or sale.

5.3 Technical Data

Raw Material Specification (husked nuts)

Kernel in nuts	44% (average)
Moisture in Kernel	50% (average)
Oil in moisture-free kernel	65%-70%

Product Yields

Coconut oil	14-15% of weight of nuts
Meal powder	8-7% of weight of nuts

Power Consumption 70-80 kwh ton of nuts

Steam Consumption 500-600 kg per ton of nuts

Water Consumption 10-20 liters per minute (make-up water)

6. Quality of Finished Products

Coconut oil : Color - 1-2R 6-12Y (Lovibond - 5¼" cell)
FFA - 0.5% maximum (average 0.2%) as lauric
Moisture not more than 0.2%

Meal Powder : 1.5R 9Y (5½" cell)
Oil Content - 7-8%
Moisture Content - 2-3%
Edible grade, about 40 mesh powder

7. Machinery Supplier: Dehydration and Extraction equipment-Anderson

8. Source of Information : P.C. Cat[illegible]an
Consultant

P.C.C. 1979